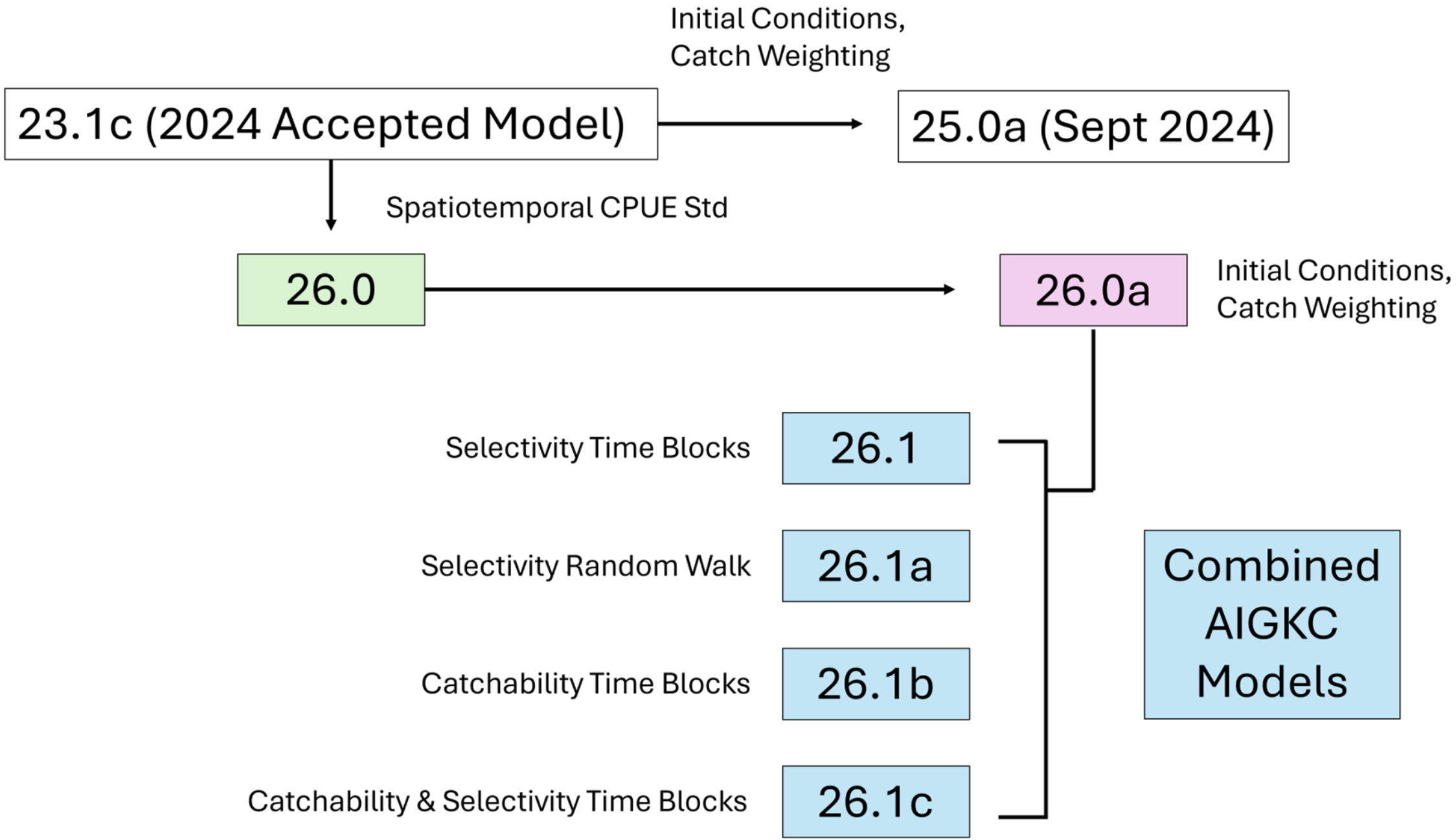
Aleutian Islands Golden King Crab 2026 Proposed Models

Tyler Jackson, ADF&G

Nov 2026 CPT


Initial Conditions,
Catch Weighting
23.1c (2024 Accepted Model)
25.0a (Sept 2024)
Spatiotemporal CPUE Std
26.0
26.0a
Initial Conditions,
Catch Weighting
Selectivity Time Blocks
26.1
Selectivity Random Walk
26.1a
Catchability Time Blocks
26.1b
Catchability & Selectivity Time Blocks
26.1c
Combined AIGKC Models

GMACS Update

Update from v2.20.21 to v2.20.31

Log of changes at bottom of TPL

Reference points equivalent (Table 2)

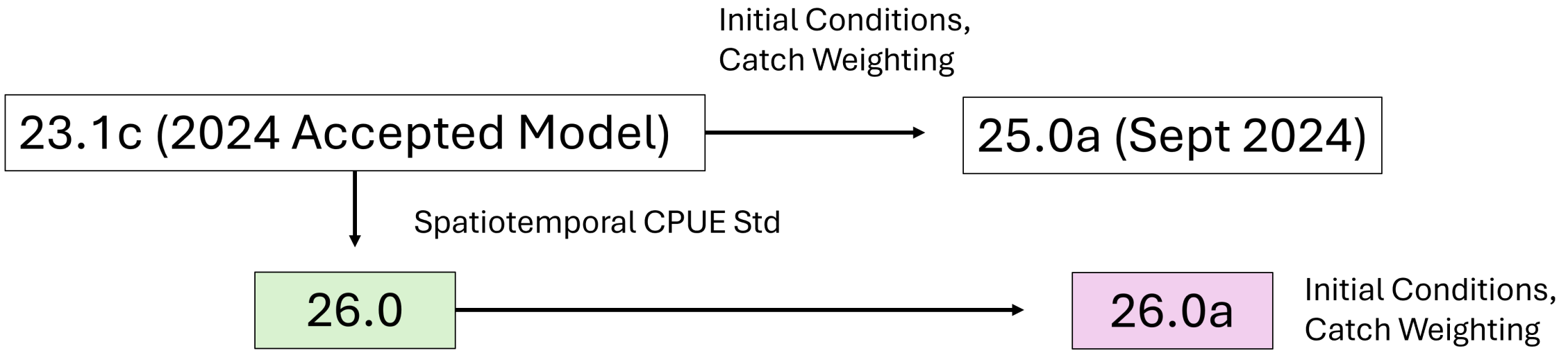
	EAG		WAG	
Component	v2.20.21	v2.20.31	v2.20.21	v2.20.31
Catch	-479.864	-479.864	-456.703	-456.703
Index	-44.874	-44.874	-69.515	-69.515
Size	827.284	827.284	1,016.130	1,016.130
Recruitment	19.200	19.200	24.486	24.486
Tagging	2,697.523	2,697.523	2,697.060	2,697.060
Penalites	0.152	0.152	0.075	0.075
Priors	26.793	26.793	26.793	26.793
Total	3,046.213	3,046.213	3,238.325	3,238.325

Initial Conditions,
Catch Weighting

23.1c (2024 Accepted Model) → 25.0a (Sept 2024)

Start model in 1981, non-equilibrium, weight catch likelihoods equally ($\lambda = 1$)

Explored in September 2024. Model 25.0b (Dirichlet multinomial) evaluated for 2025 final assessment instead



CPUE standardization using *sdmTMB* spatiotemporal model (Appendix A)

Observer index time series from 1995 – 2024

- Catchability (*q*) time blocks corresponding to rationalization (1995 – 2004; 2005 – 2024)
- Best practice to have continuous index, handle changes due to rationalization within model (*q* scaled differently)

Appendix A : CPUE Standardization

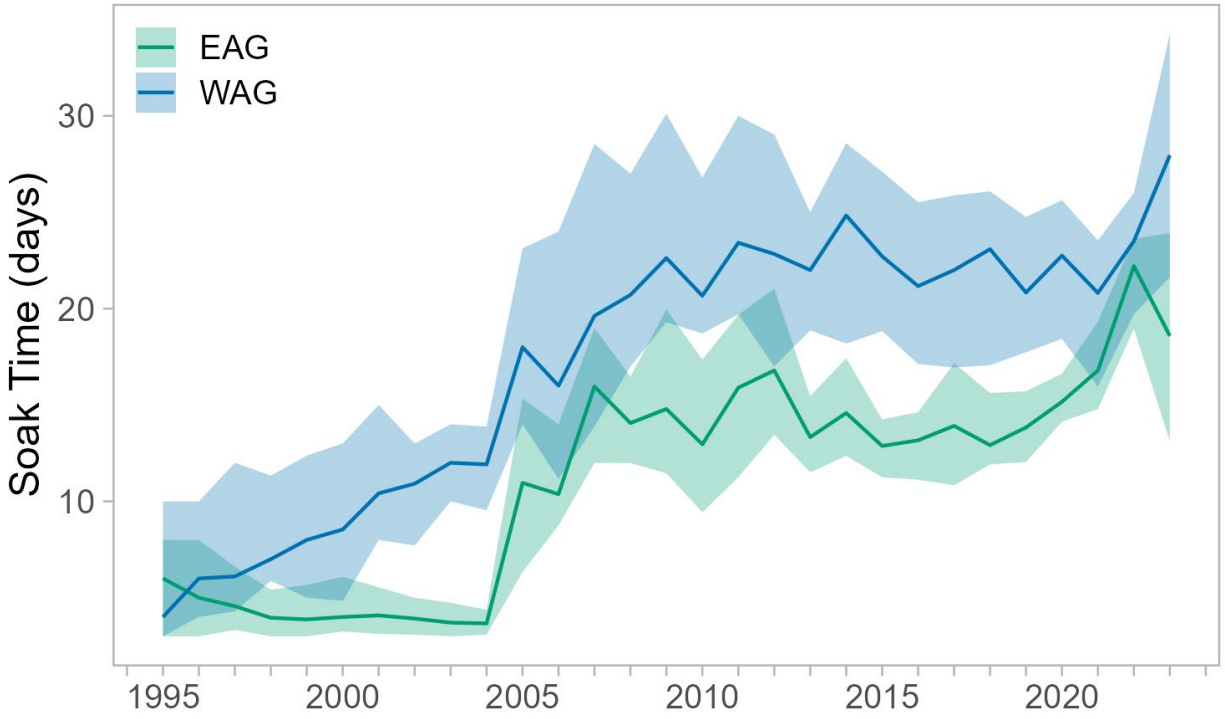
Presented to CPT *briefly* in May 2025

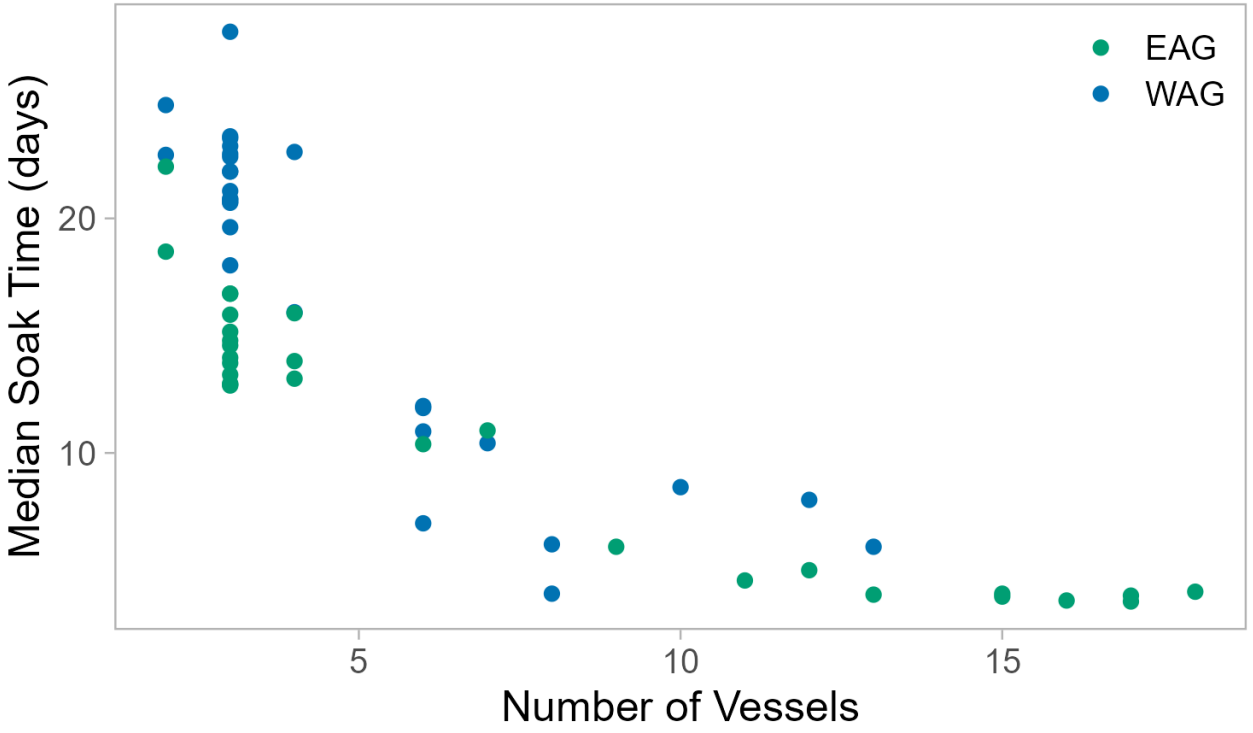
CPUE ~ Year + Gear + s(soak time) + s(depth) + (1|Vessel)

CPUE ~ Year + Gear + s(soak time:Rationalized) + s(depth) + (1|Vessel)

Tweedie, estimate *p*

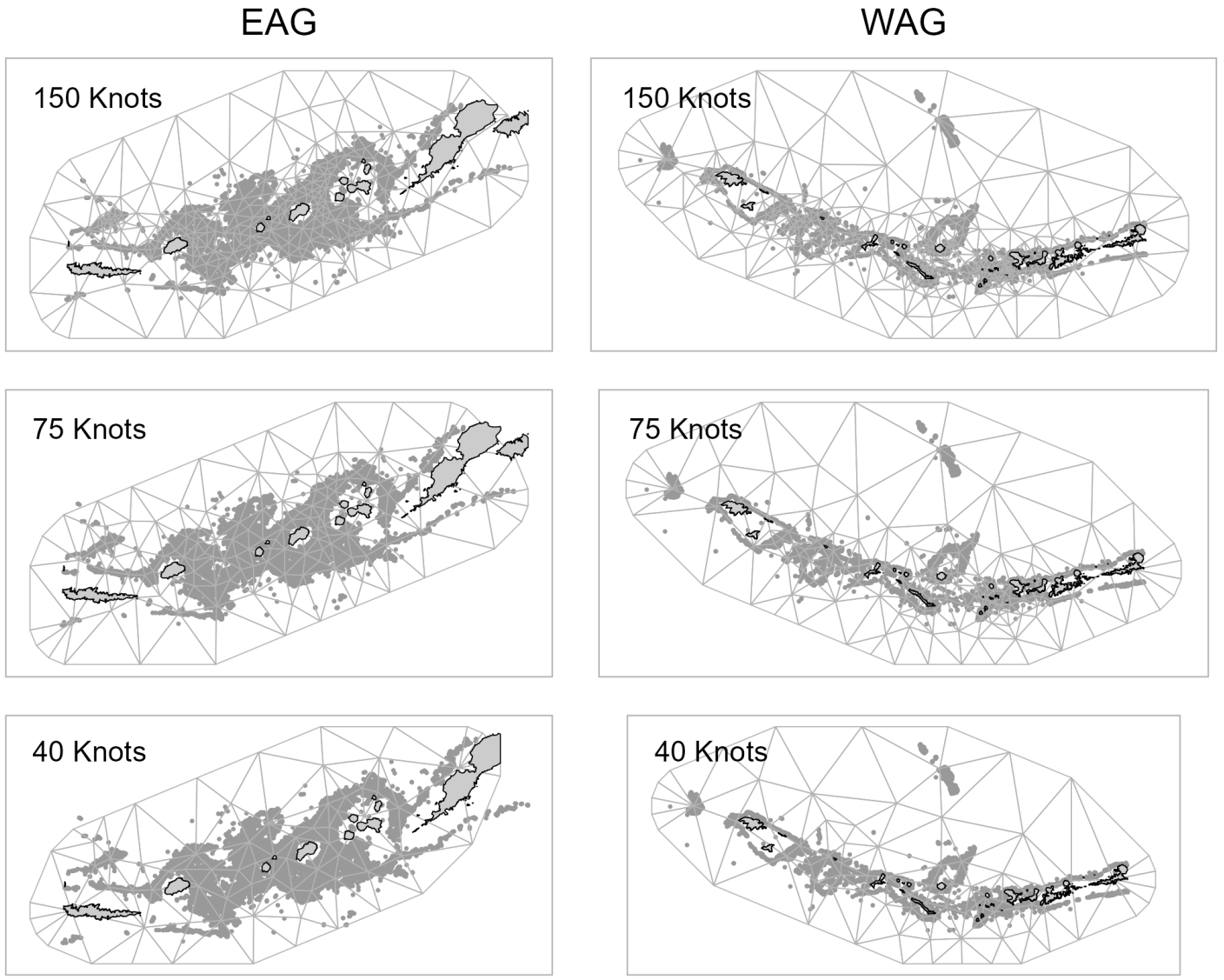
SSC June 2025: *A spatiotemporal model is encouraged. However, the inclusion of the interaction term between soak time and year may alias changes in relative abundance. Some rationale should be given as to including that interaction or this element should be eliminated*

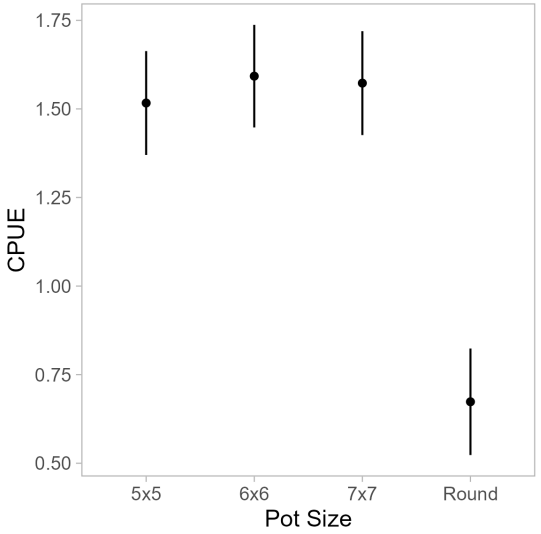


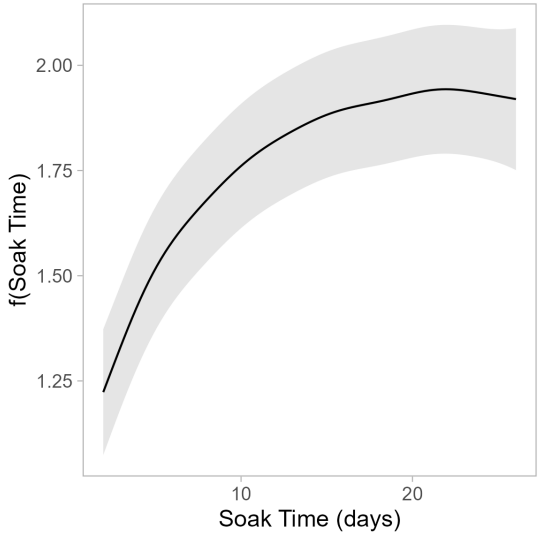


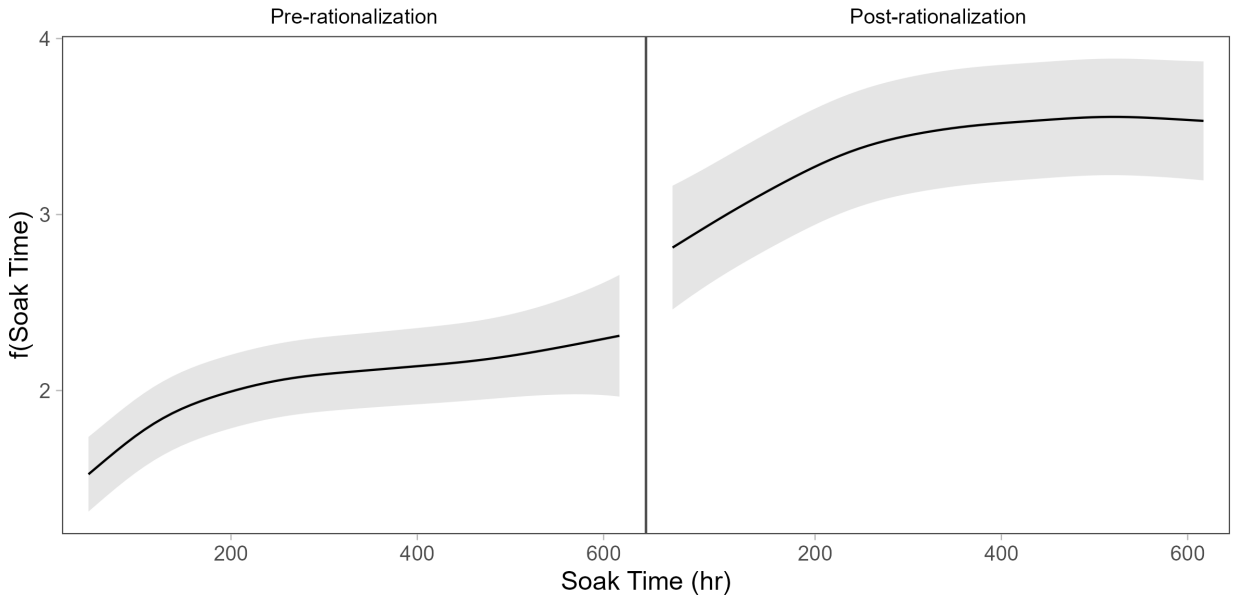
Barrier Mesh

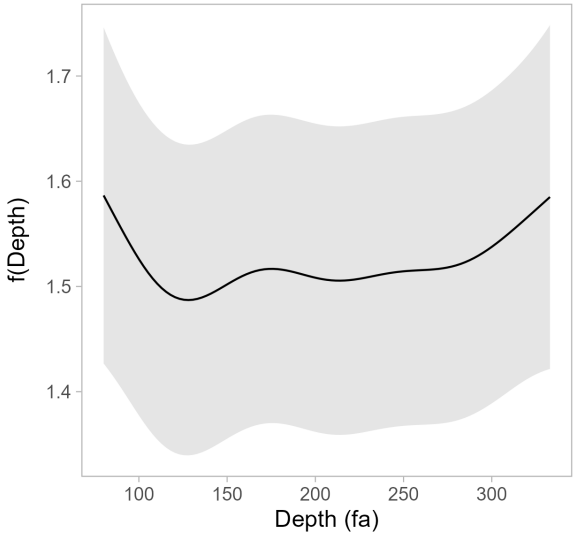
Kmeans w/ 150, 75, or 40 knots based on UTM coordinate in zone specific to EAG and WAG





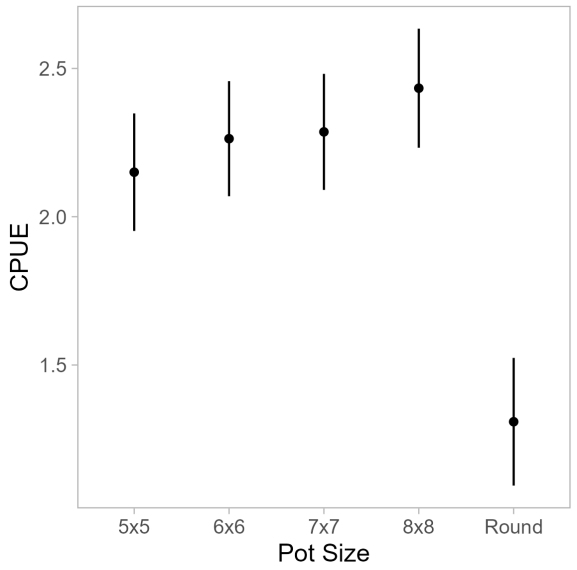


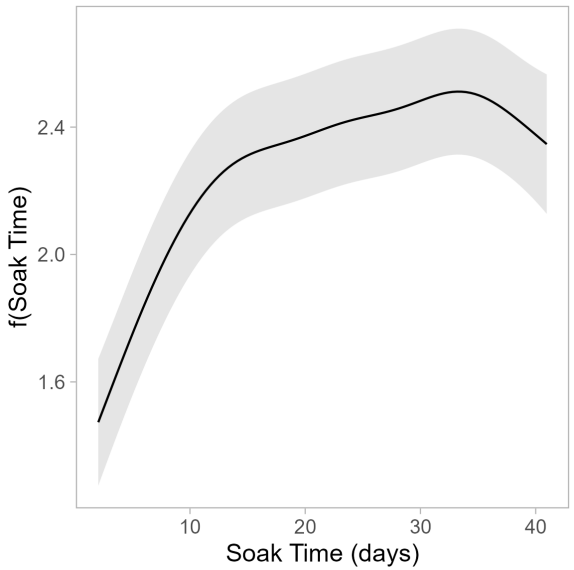


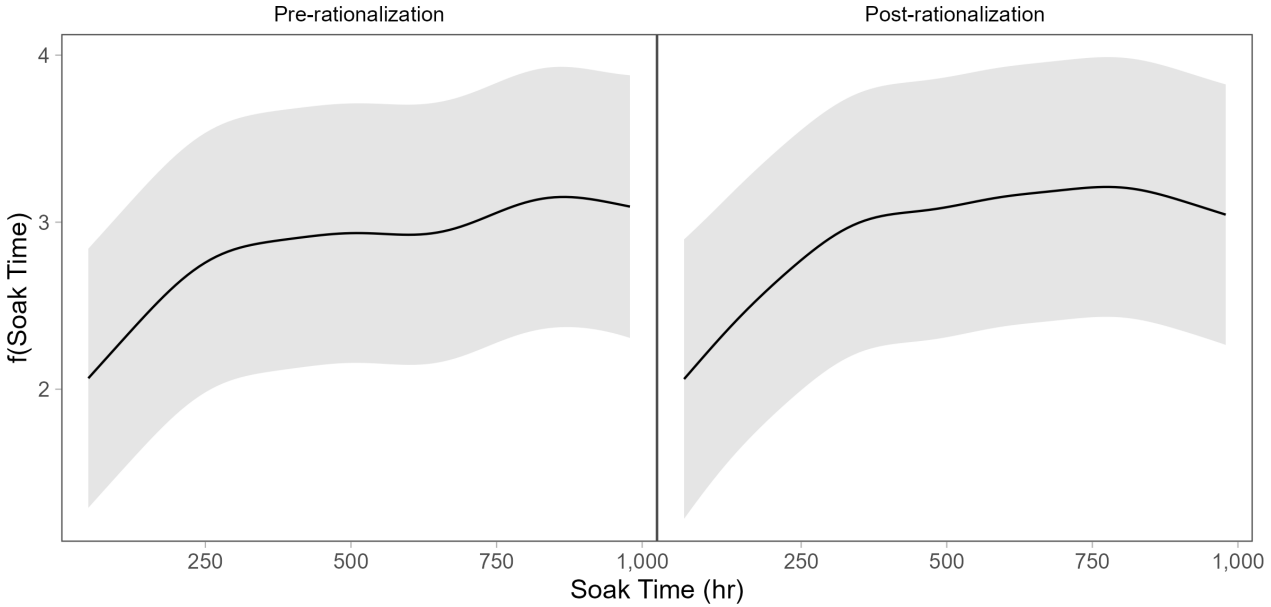


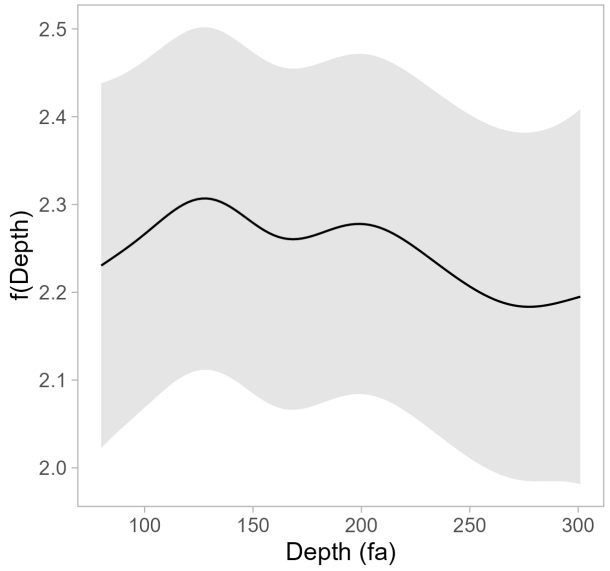
EAG

Addition of soak time interaction improved deviance explained < 0.1%







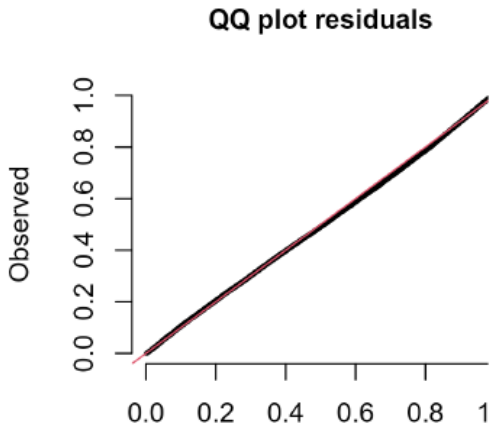


WAG

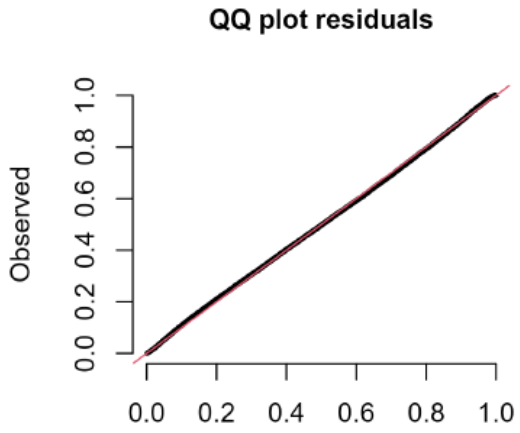
Addition of soak time interaction improved deviance explained < 0.1%

EAG

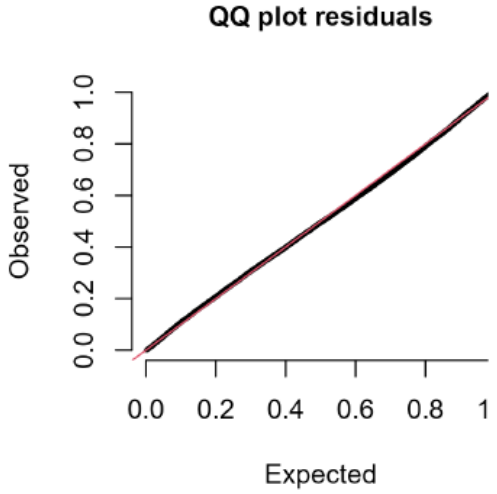
a)



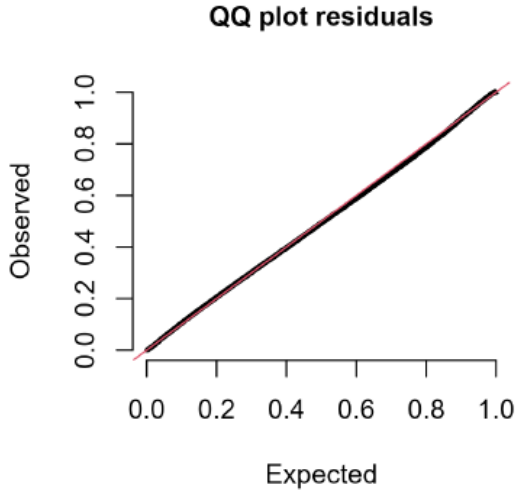
b)



c)

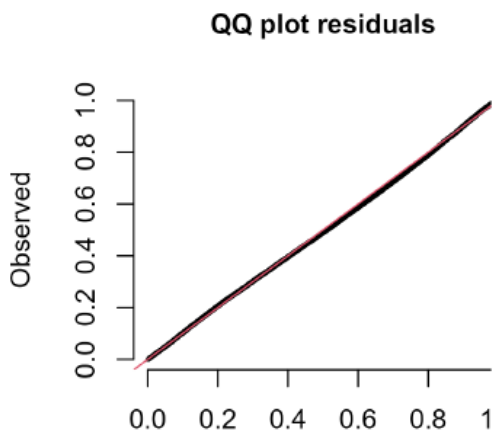


d)

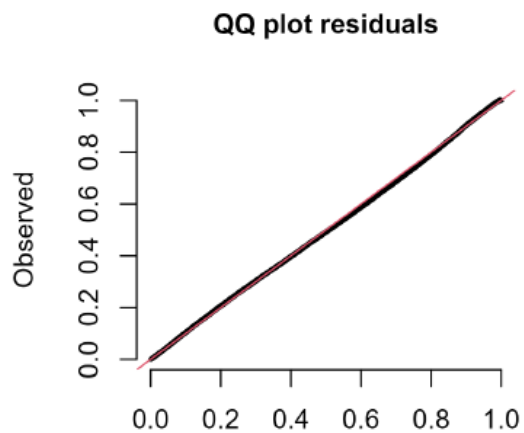


WAG

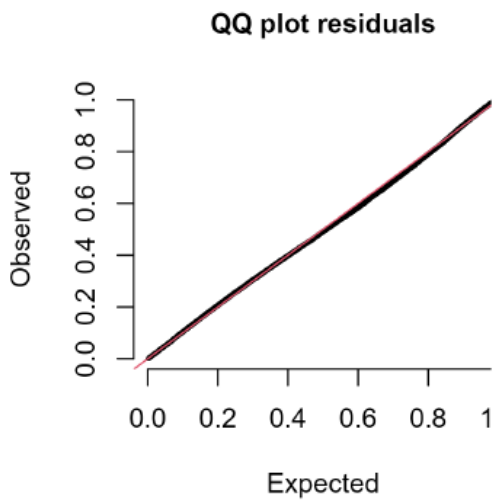
a)



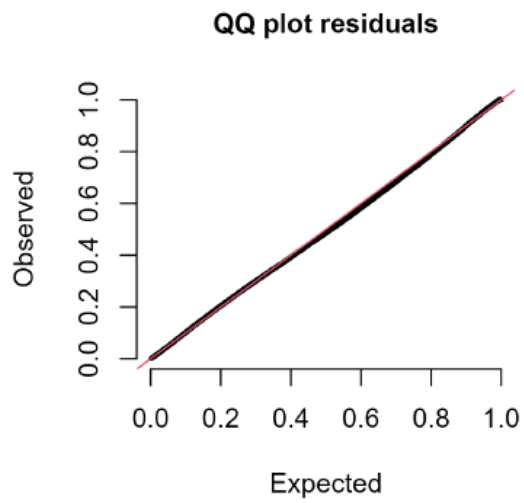
b)



c)

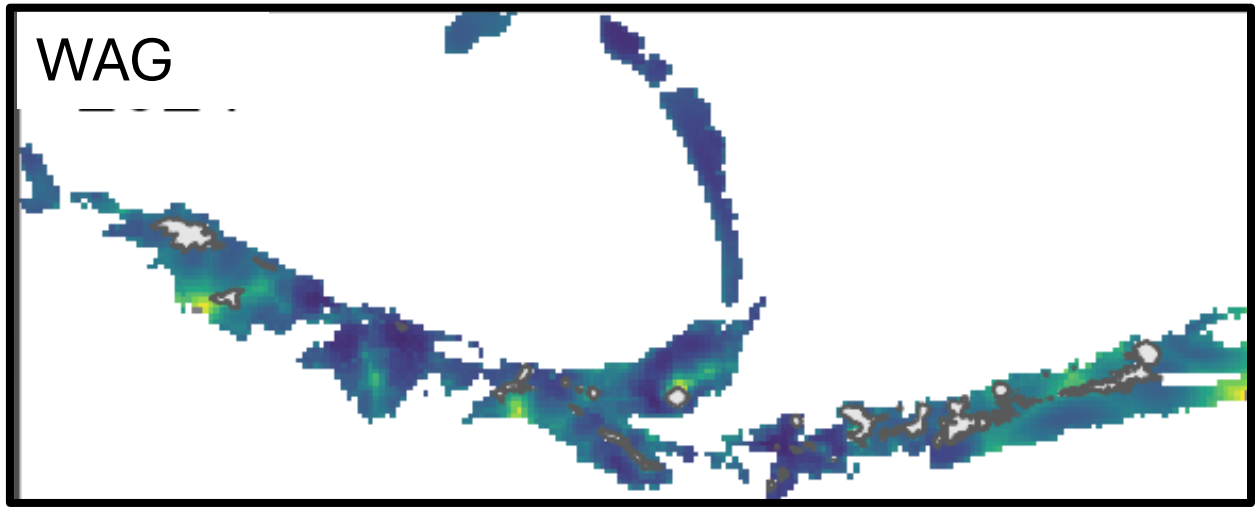


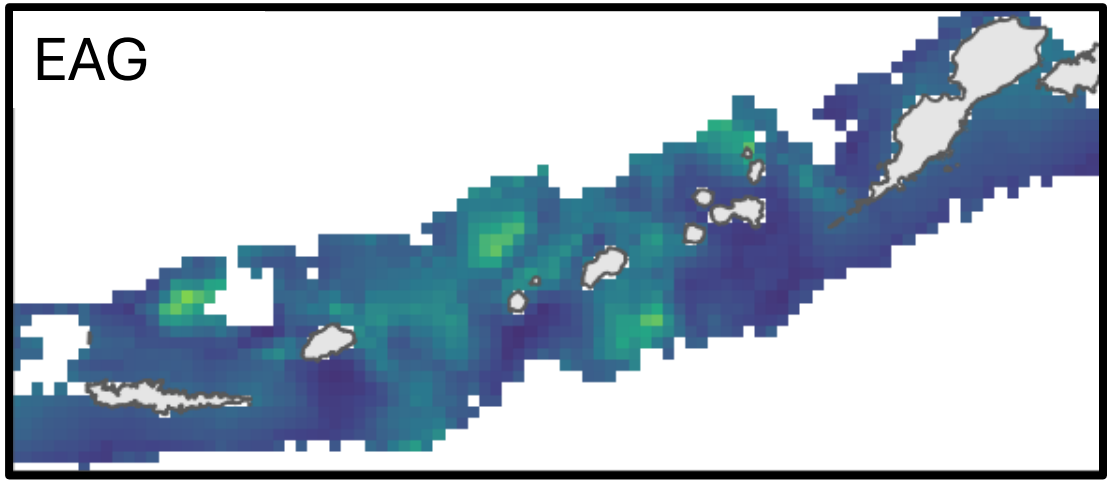
d)



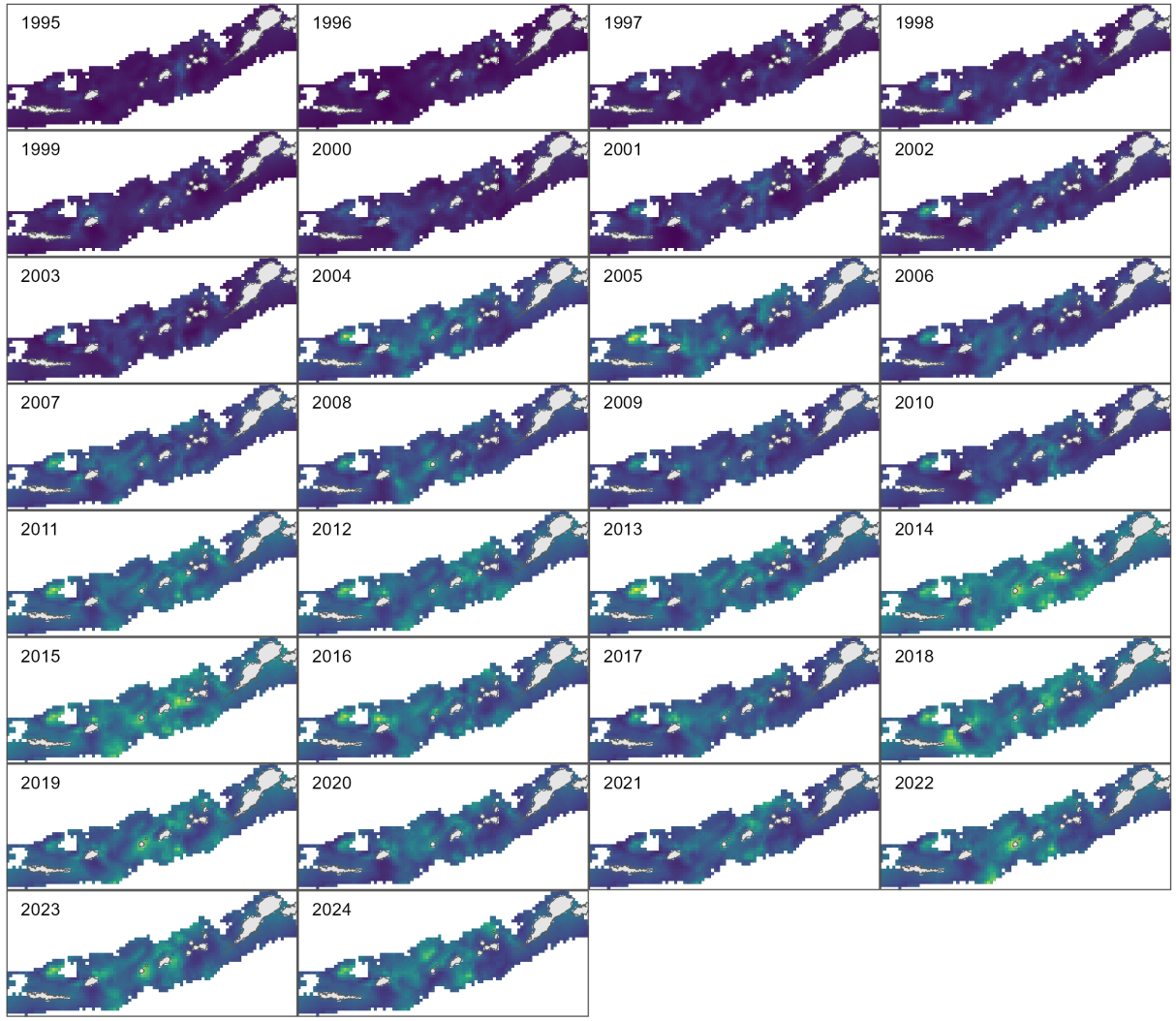
Prediction Grid

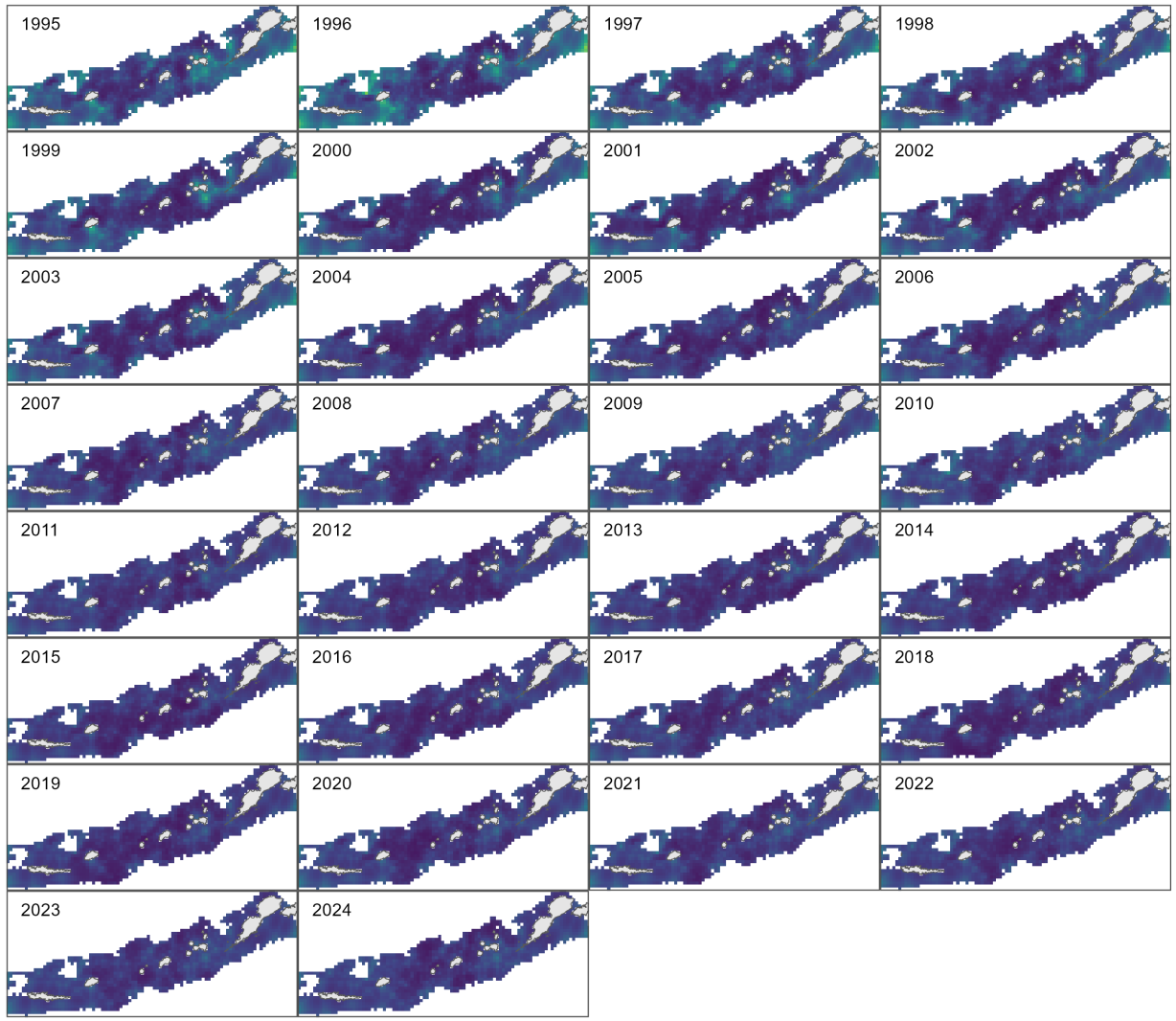
- 5 km2 grid within meh boundary
- Depth from Aleutian Islands 100 m bathymetry (Zimmerman and Prescott 2021)
- Trimmed depths > 1.5 x max depth in observer data
- Vessel not included

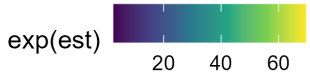




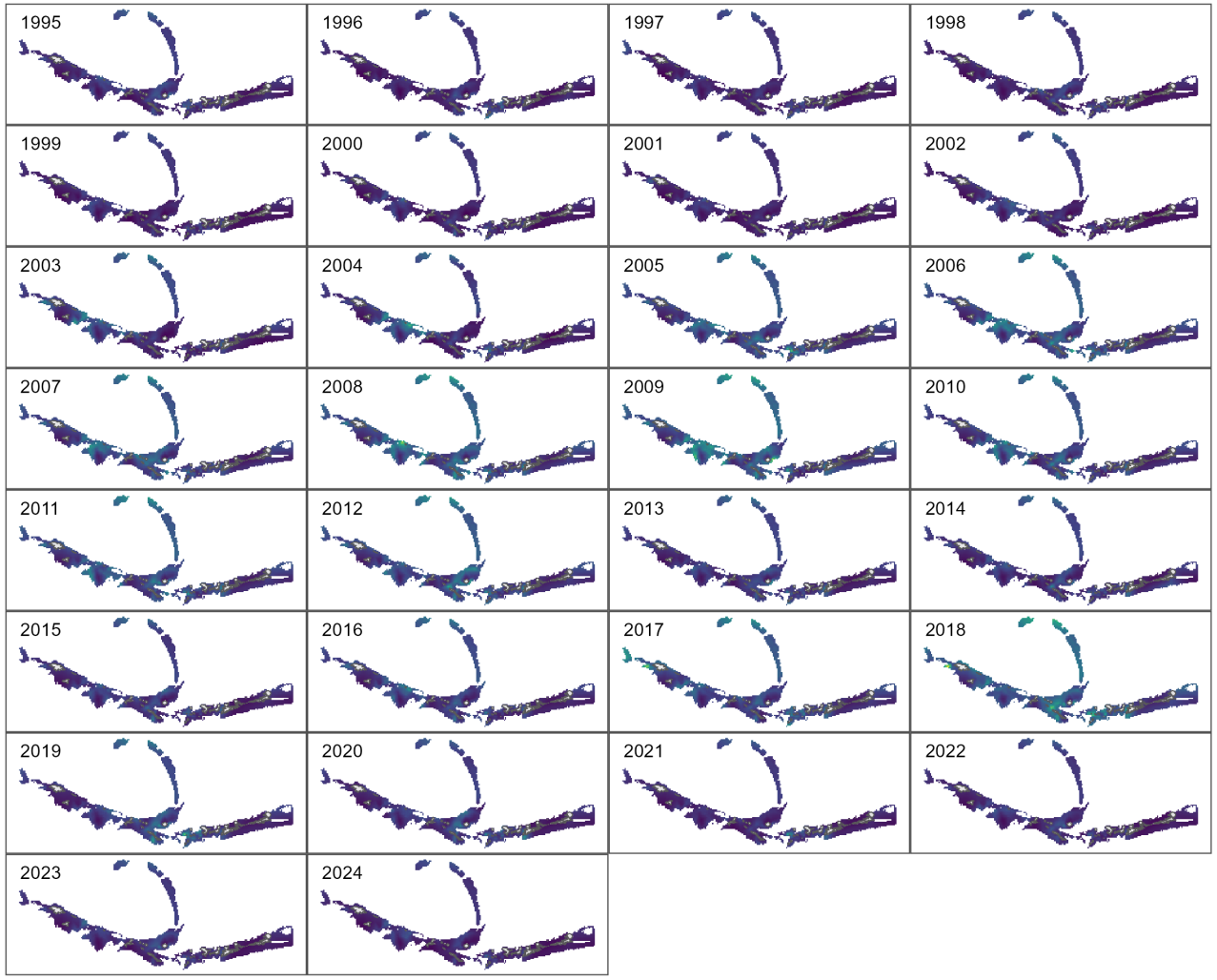
EAG Predictions

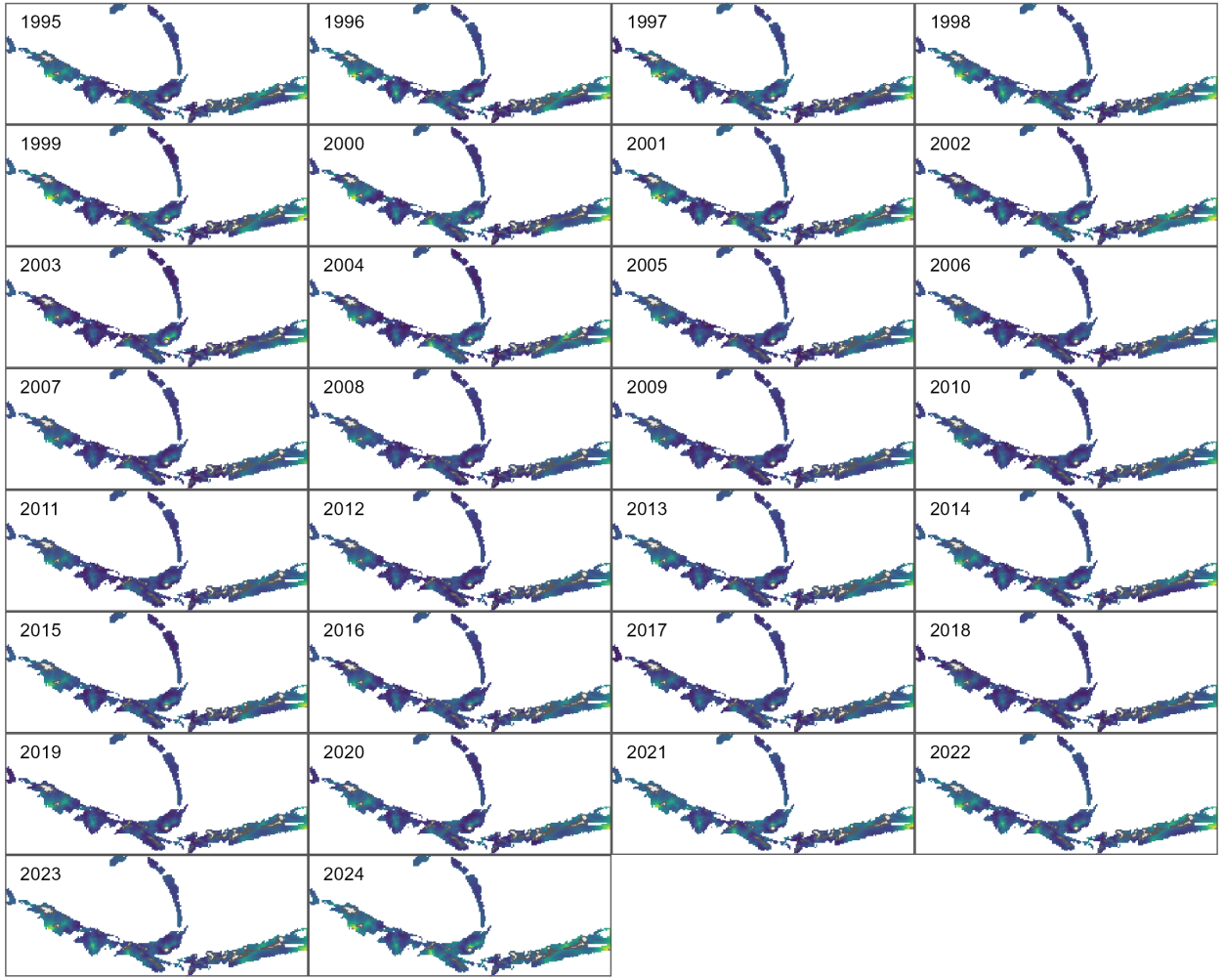


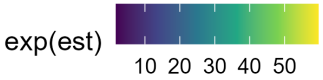


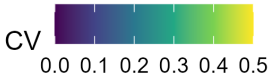


WAG Predictions





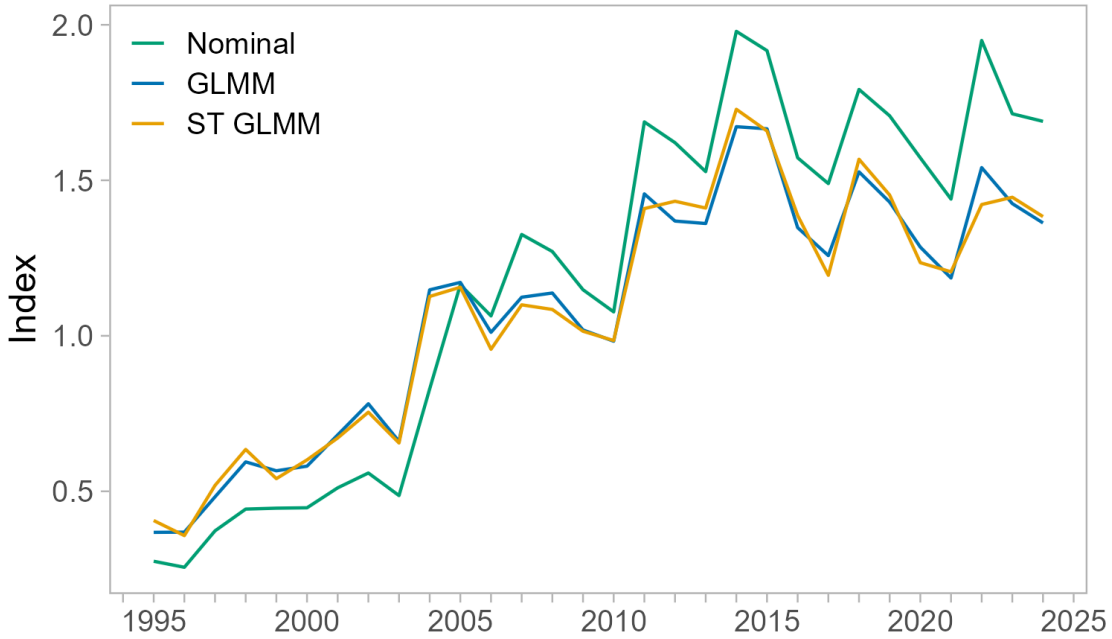


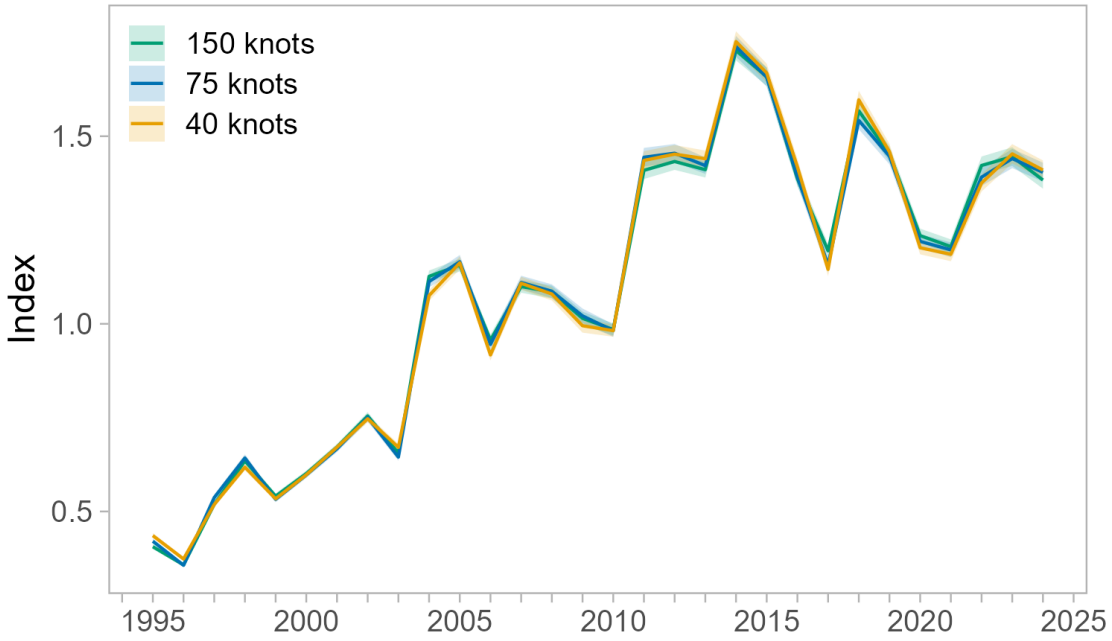


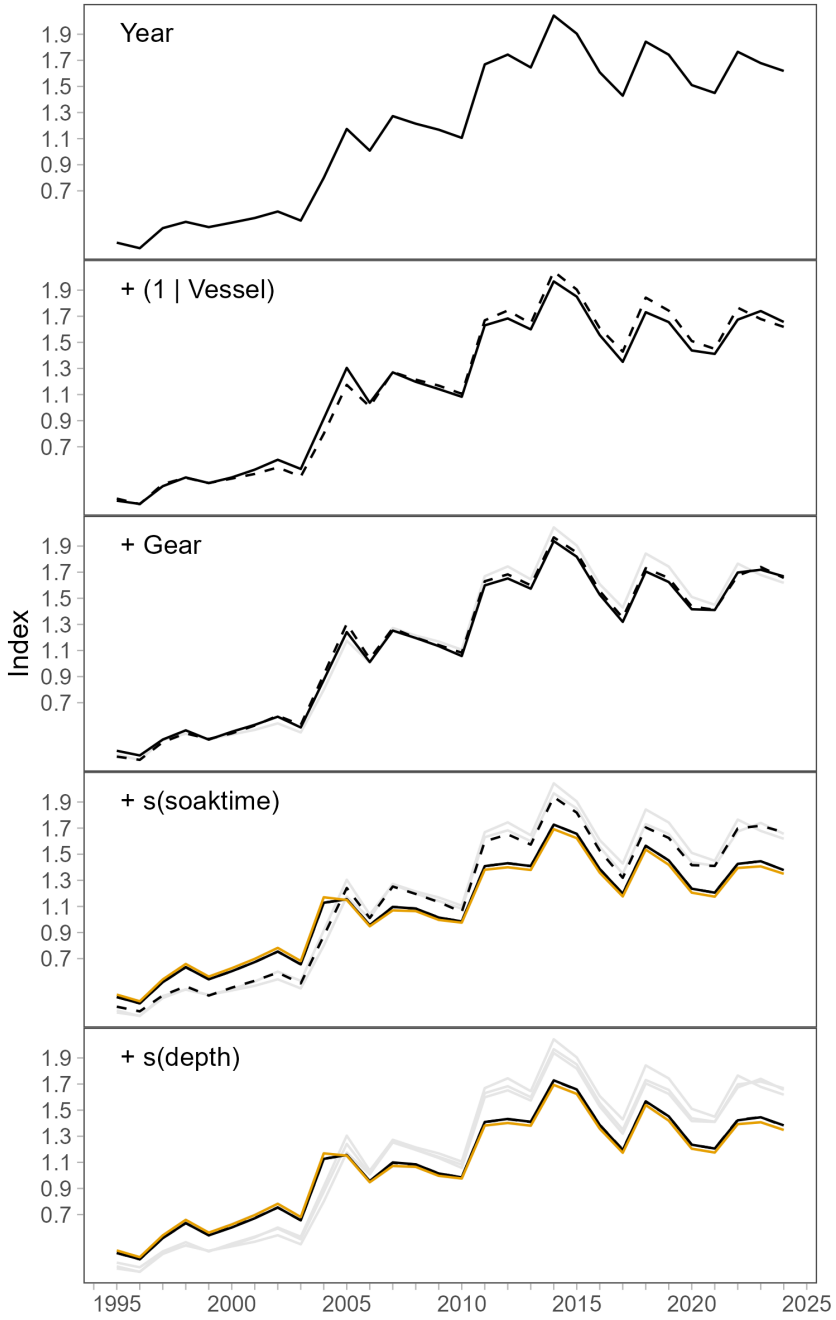
Moran's *I* (Table A1)

- High resolution mesh resolved more spatial autocorrelation
- Larger Moran's *I* earlier in time series
- Values low, but significant – sample sizes are large

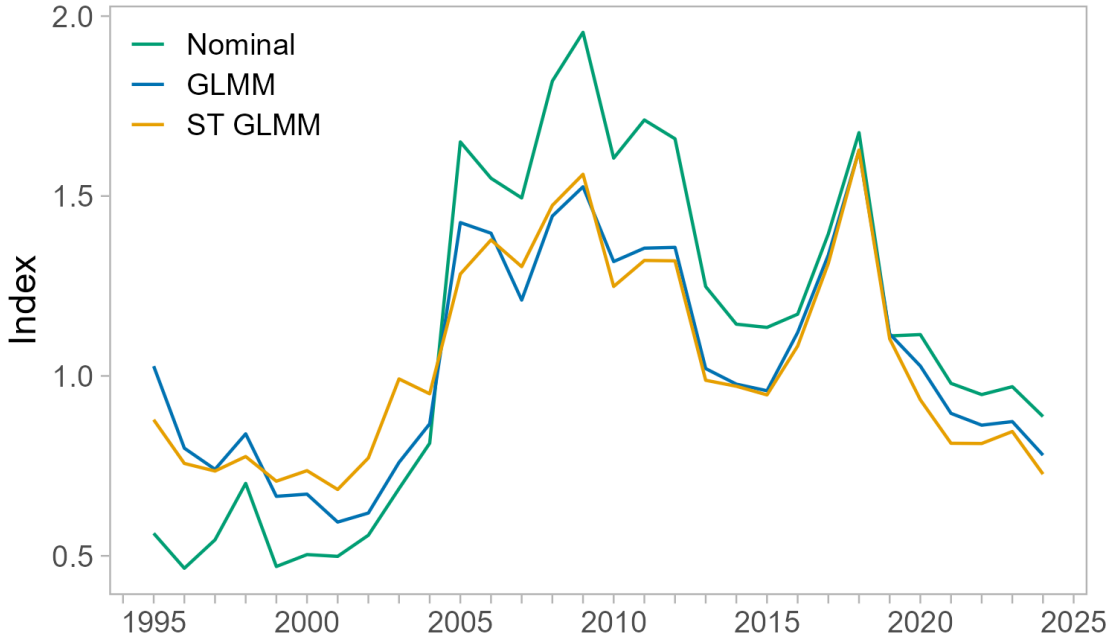
EAG

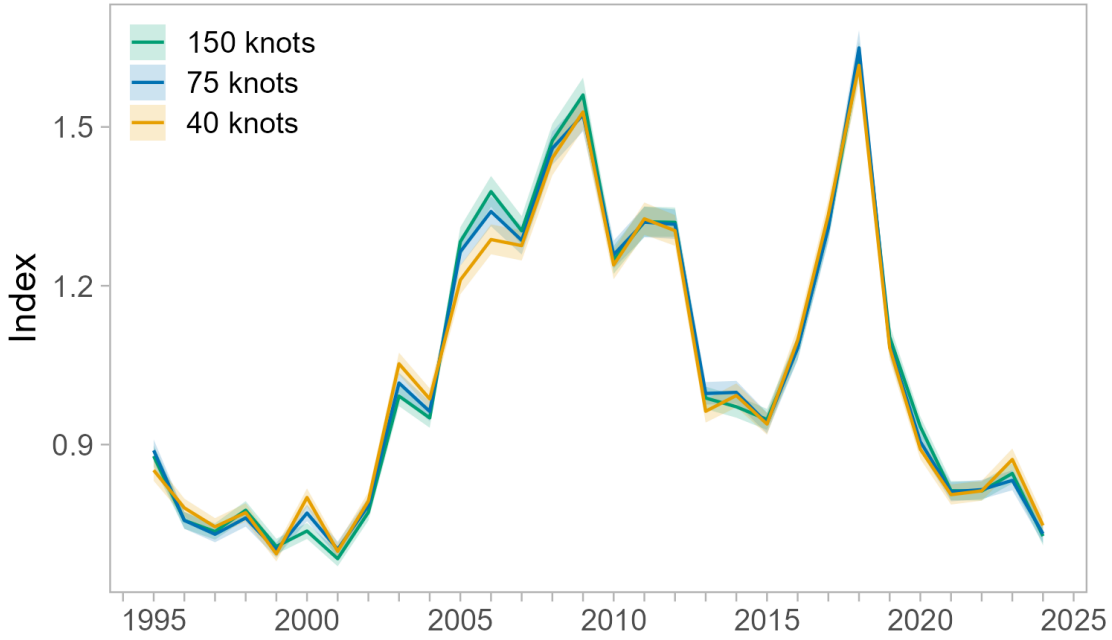

Nominal
GLMM
ST GLMM
Index
2.0
1.5
1.0
0.5
1995
2000
2005
2010
2015
2020
2025

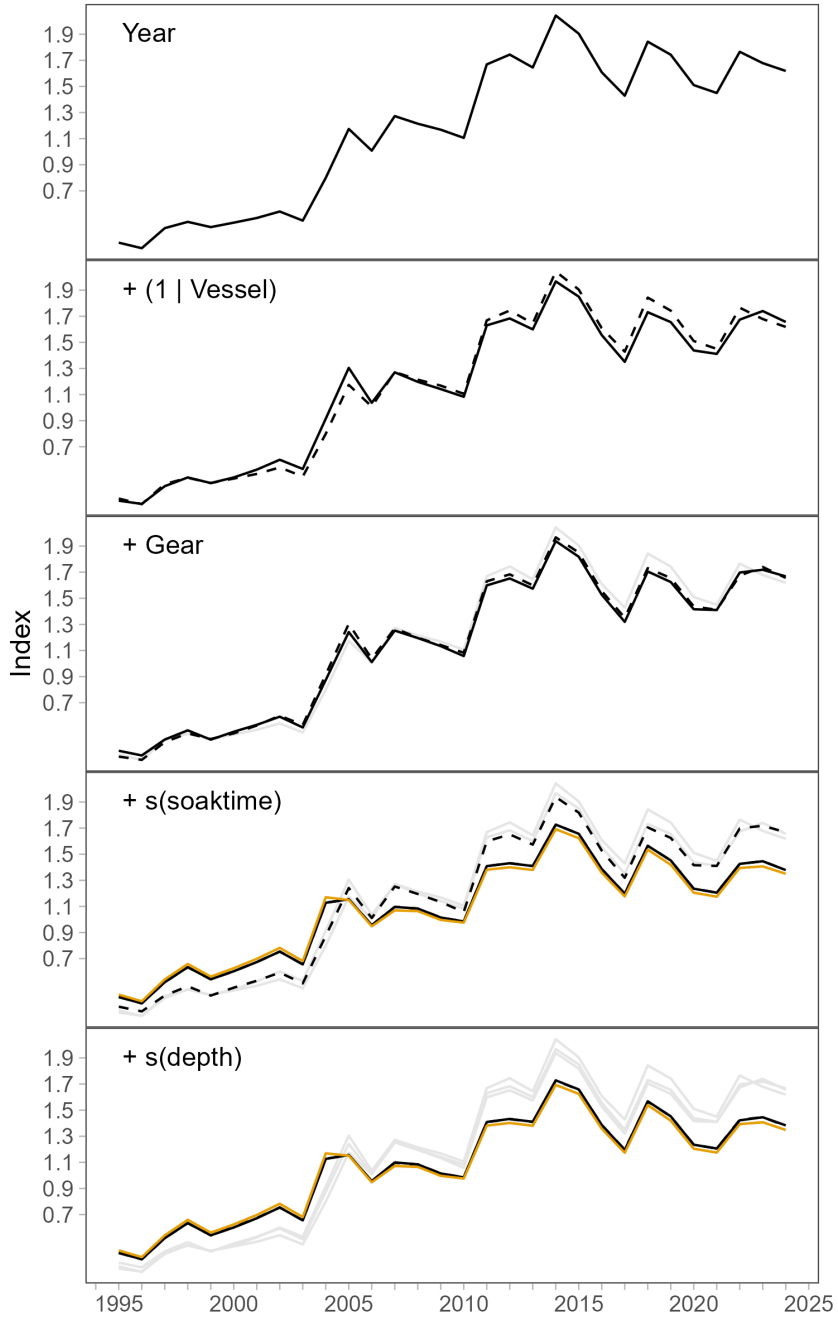

150 knots
75 knots
40 knots
Index
1.5
1.0
0.5
1995
2000
2005
2010
2015
2020
2025


Year
+ (1 | Vessel)
+ Gear
+ s(soaktime)
+ s(depth)
Index
1.9
1.7
1.5
1.3
1.1
0.9
0.7
1995
2000
2005
2010
2015
2020
2025

WAG


Nominal
GLMM
ST GLMM
Index
2.0
1.5
1.0
0.5
1995
2000
2005
2010
2015
2020
2025


150 knots
75 knots
40 knots
Index
1.5
1.2
0.9
1995
2000
2005
2010
2015
2020
2025


Year
+ (1 | Vessel)
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+ s(depth)
Index
1.9
1.7
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1.3
1.1
0.9
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1995
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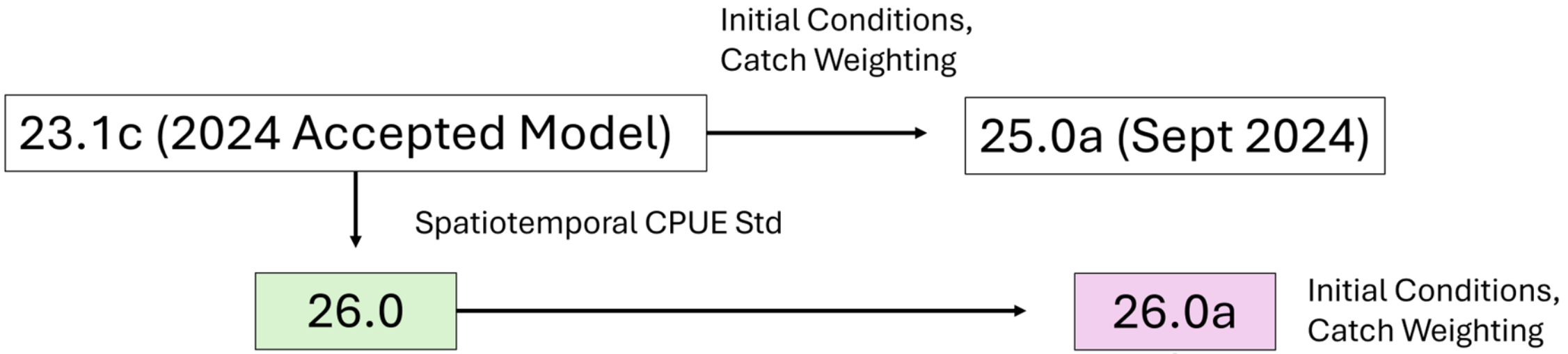
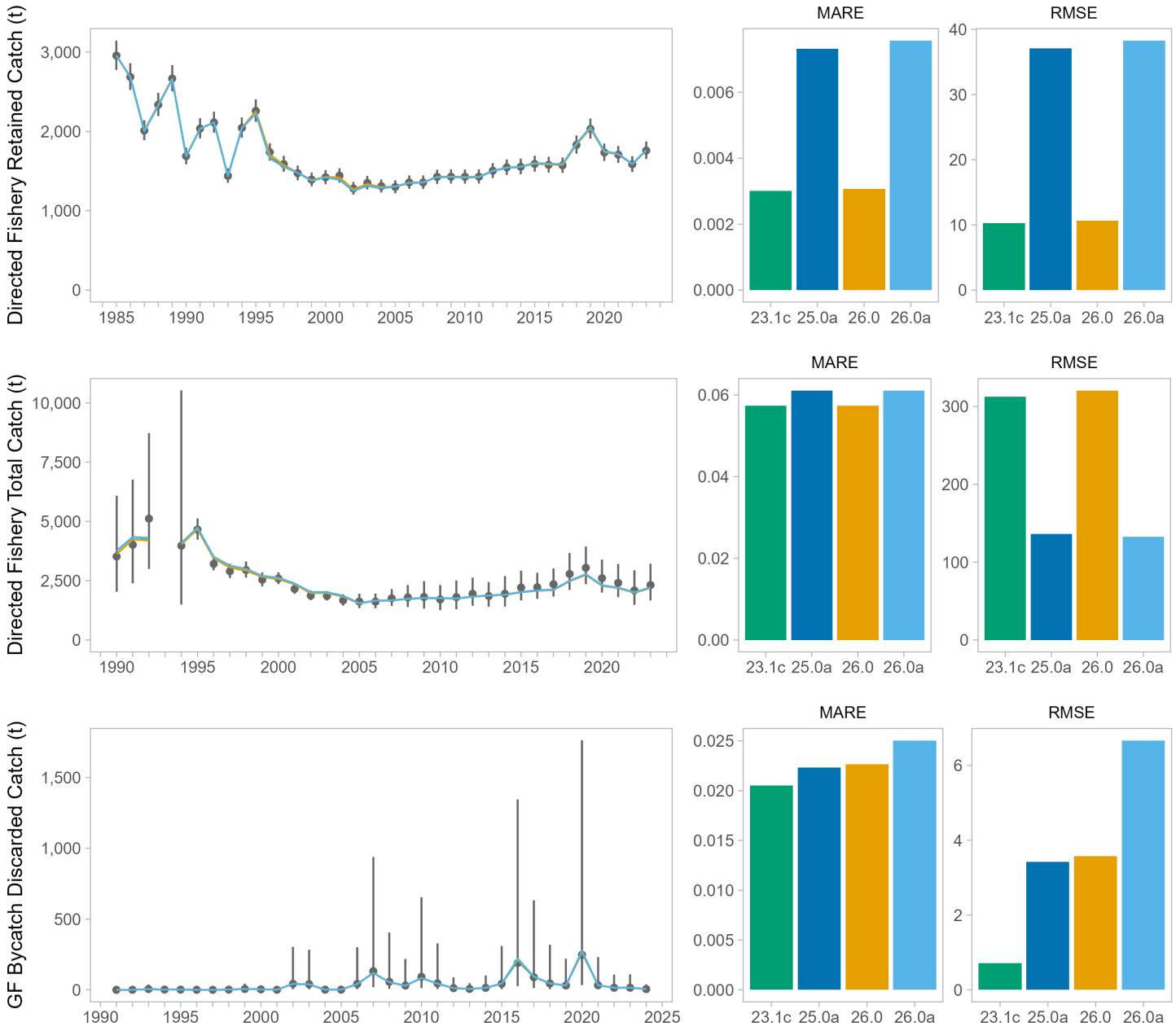
2025



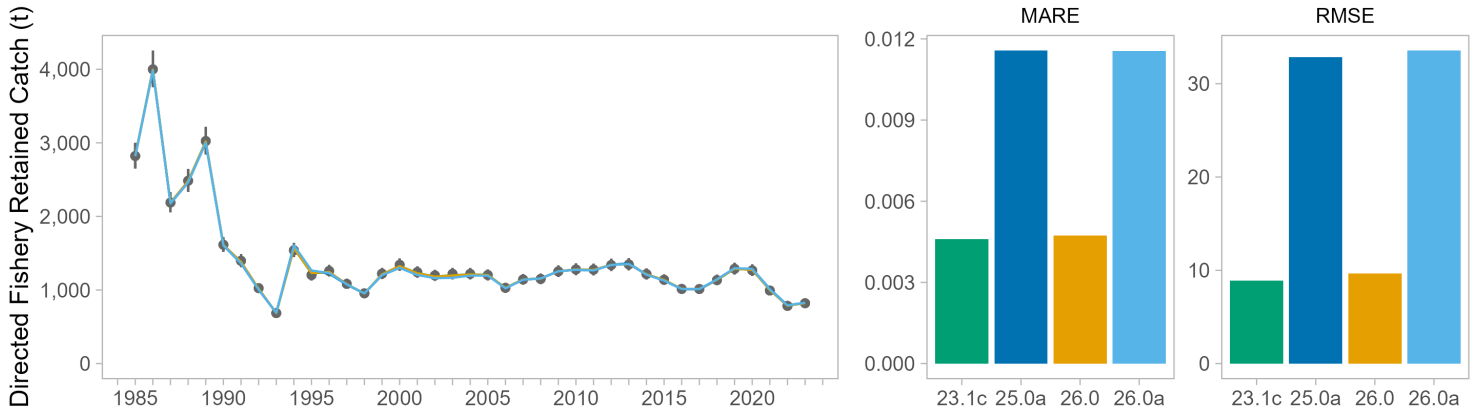
Start model in non-equilibrium conditions in 1981

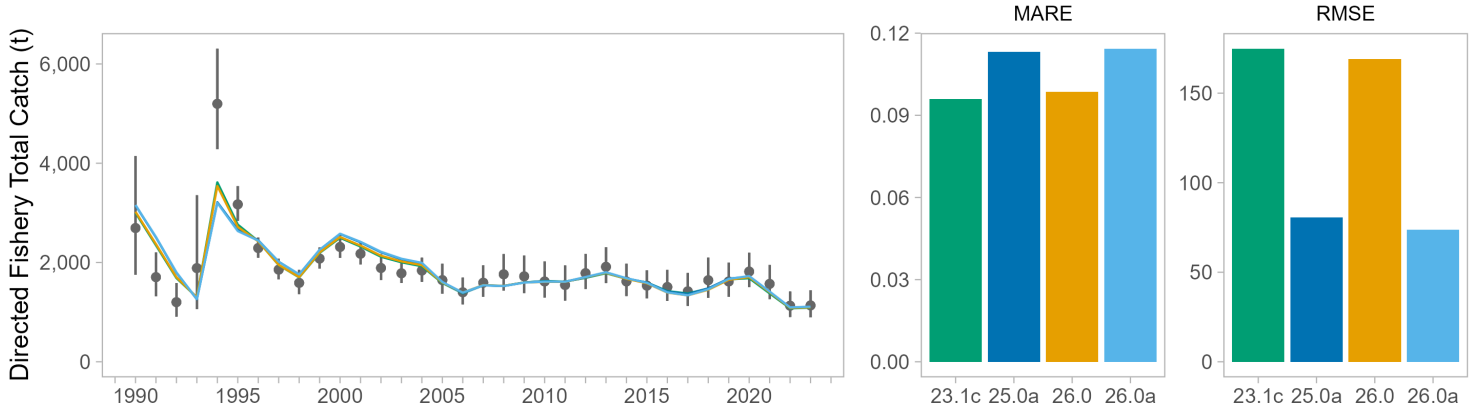
- Remove 22 parameters for R_0 and 1960-1980 recruitment deviations
- Add 18 parameters for R_{init}, N at size deviations, and $\bar{R}$
- 136 – 140 mm CL as reference size class

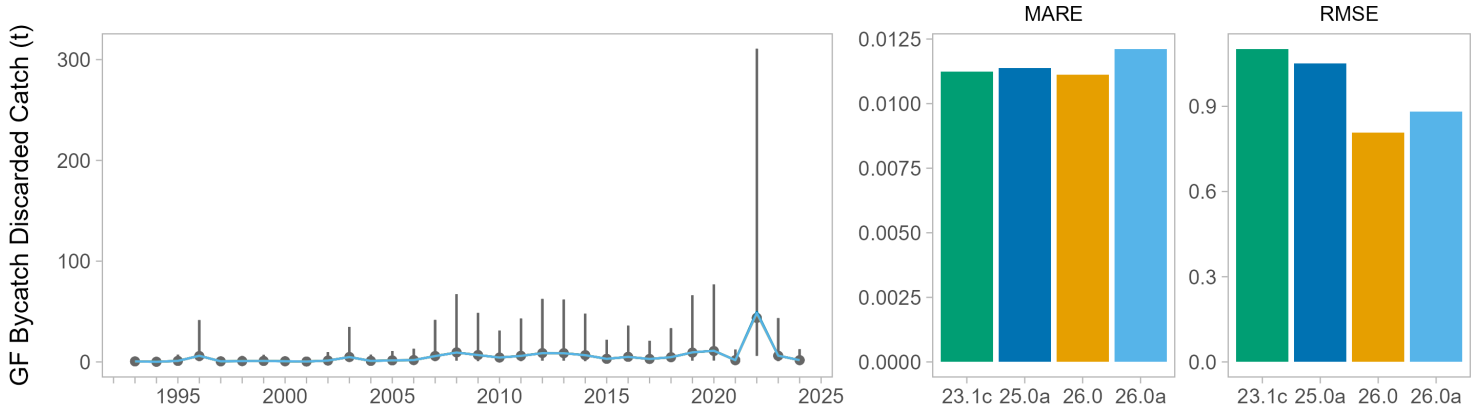
EAG Catch Series

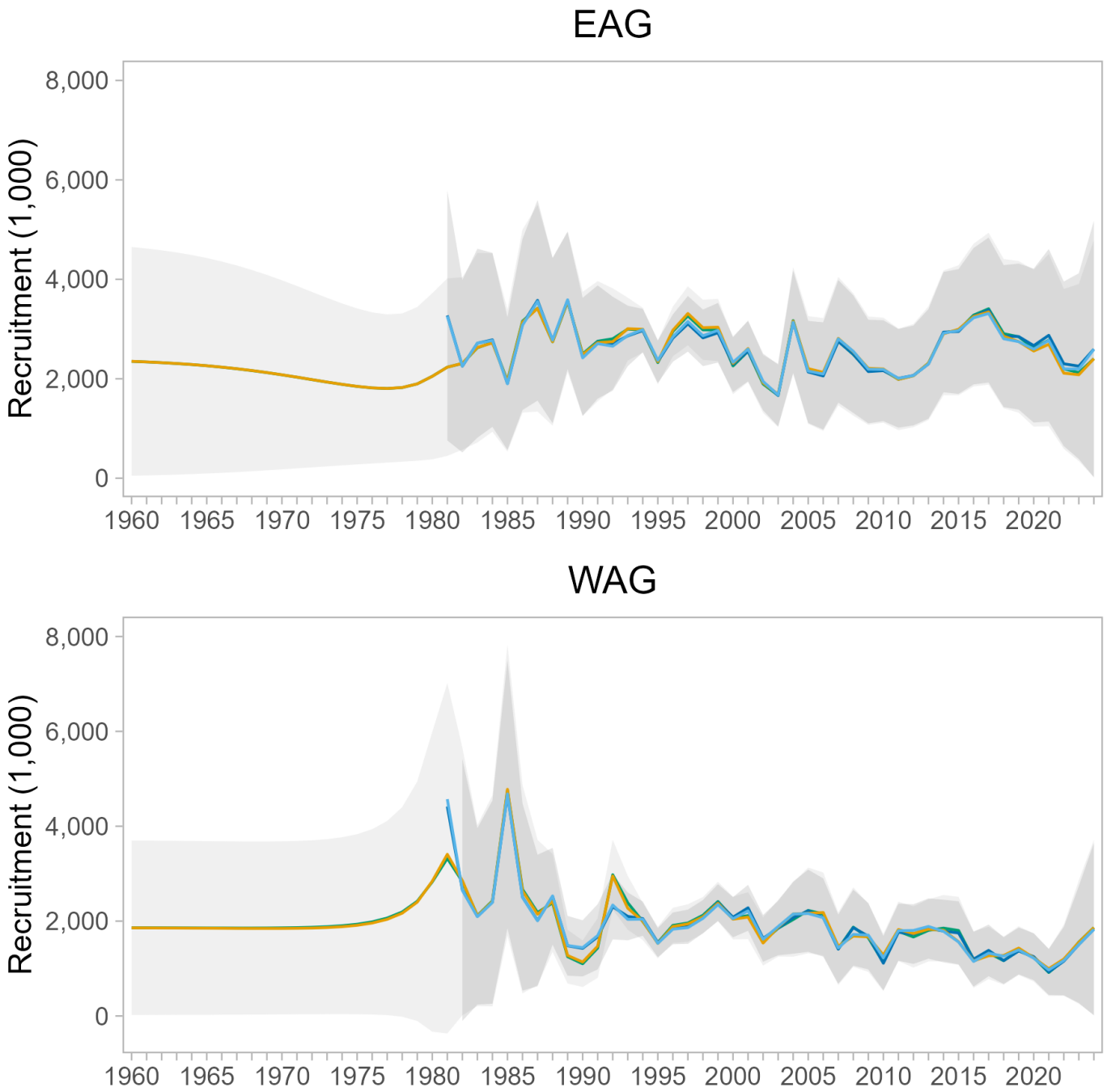


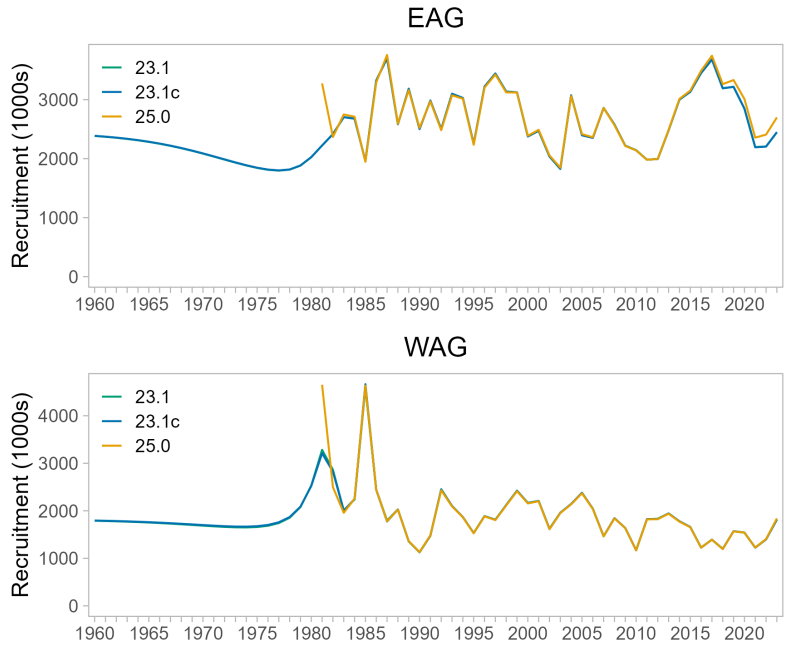
WAG Catch Series

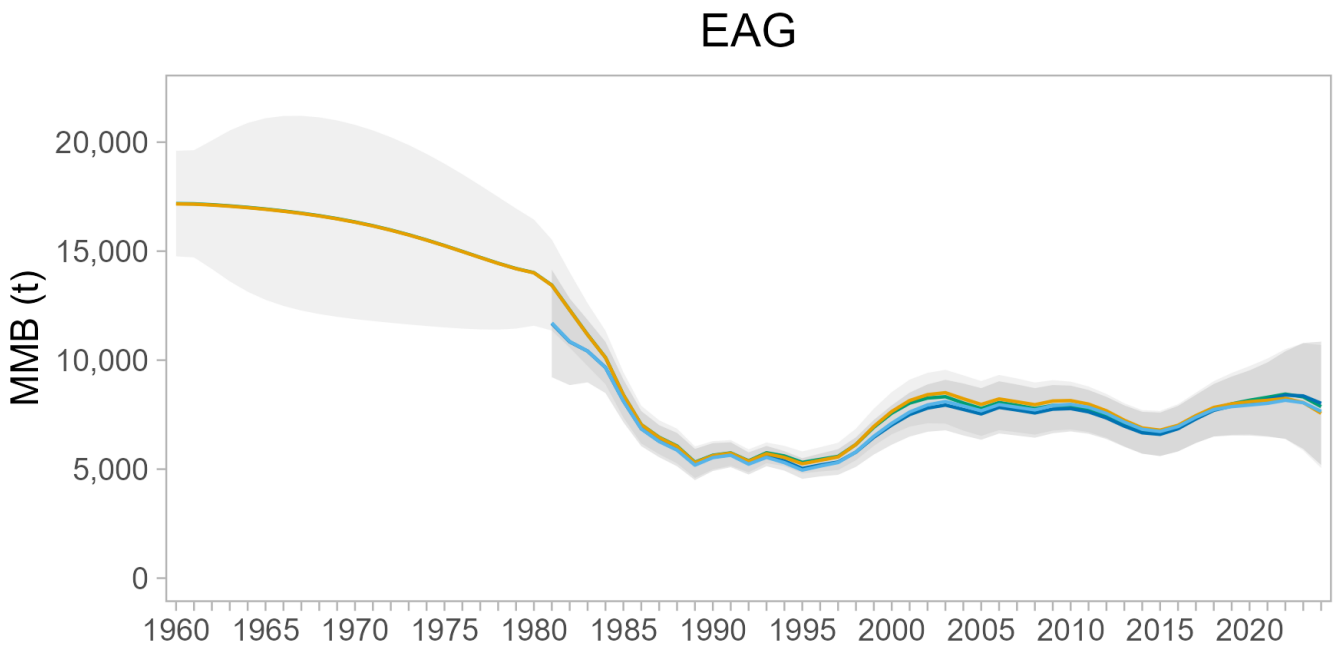


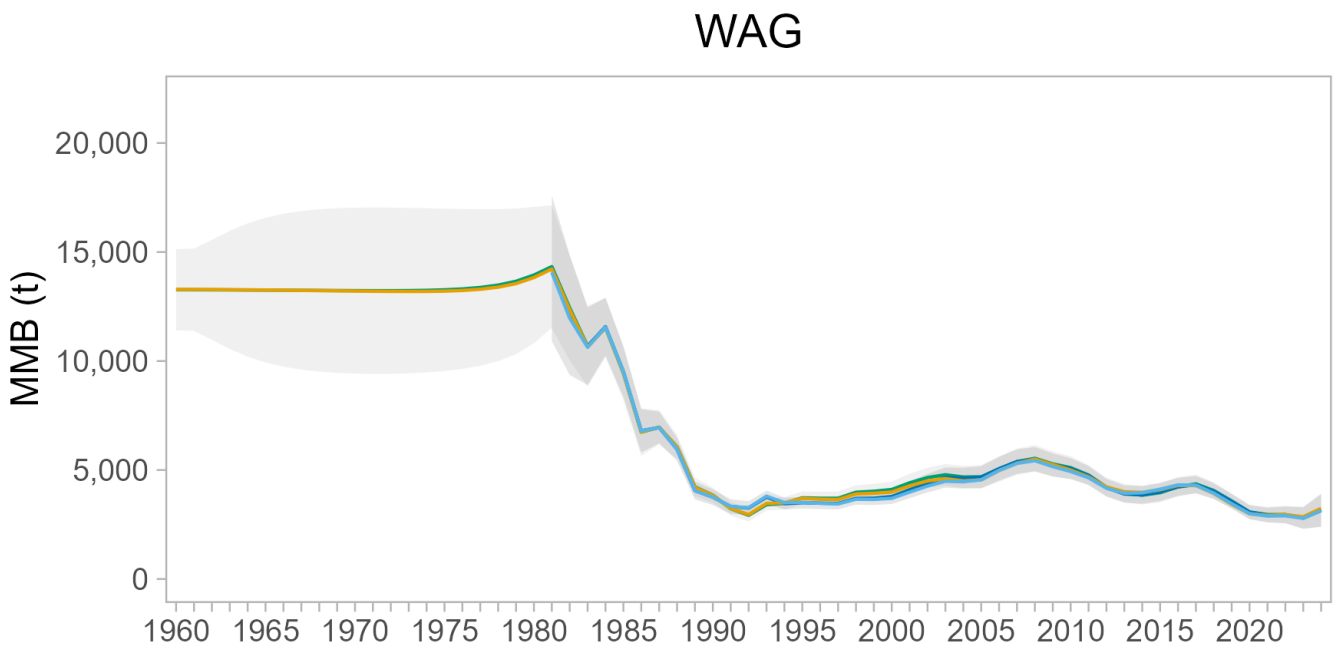




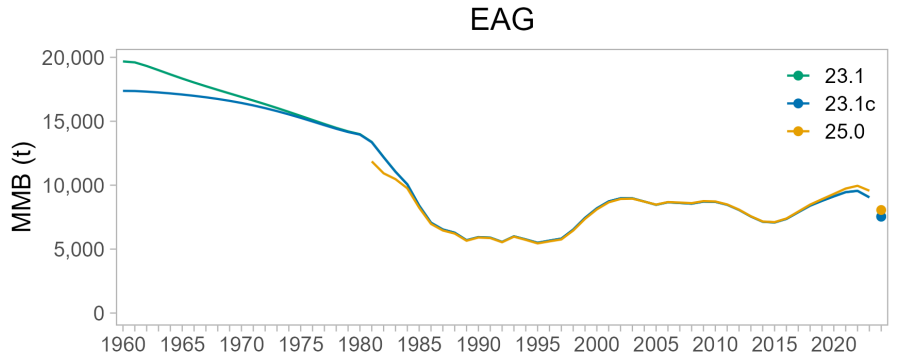

EAG
Recruitment (1,000)
8,000
6,000
4,000
2,000
0
1960 1965 1970 1975 1980 1985 1990 1995 2000 2005 2010 2015 2020
WAG
Recruitment (1,000)
8,000
6,000
4,000
2,000
0
1960 1965 1970 1975 1980 1985 1990 1995 2000 2005 2010 2015 2020
23.1c
25.0a
26.0
26.0a

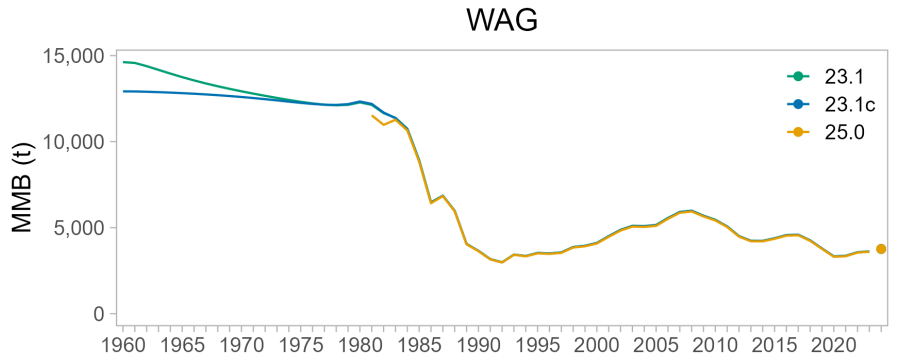

EAG
Recruitment (1000s)
3000
2000
1000
0
23.1
23.1c
25.0
1960 1965 1970 1975 1980 1985 1990 1995 2000 2005 2010 2015 2020
WAG
Recruitment (1000s)
4000
3000
2000
1000
0
23.1
23.1c
25.0
1960 1965 1970 1975 1980 1985 1990 1995 2000 2005 2010 2015 2020

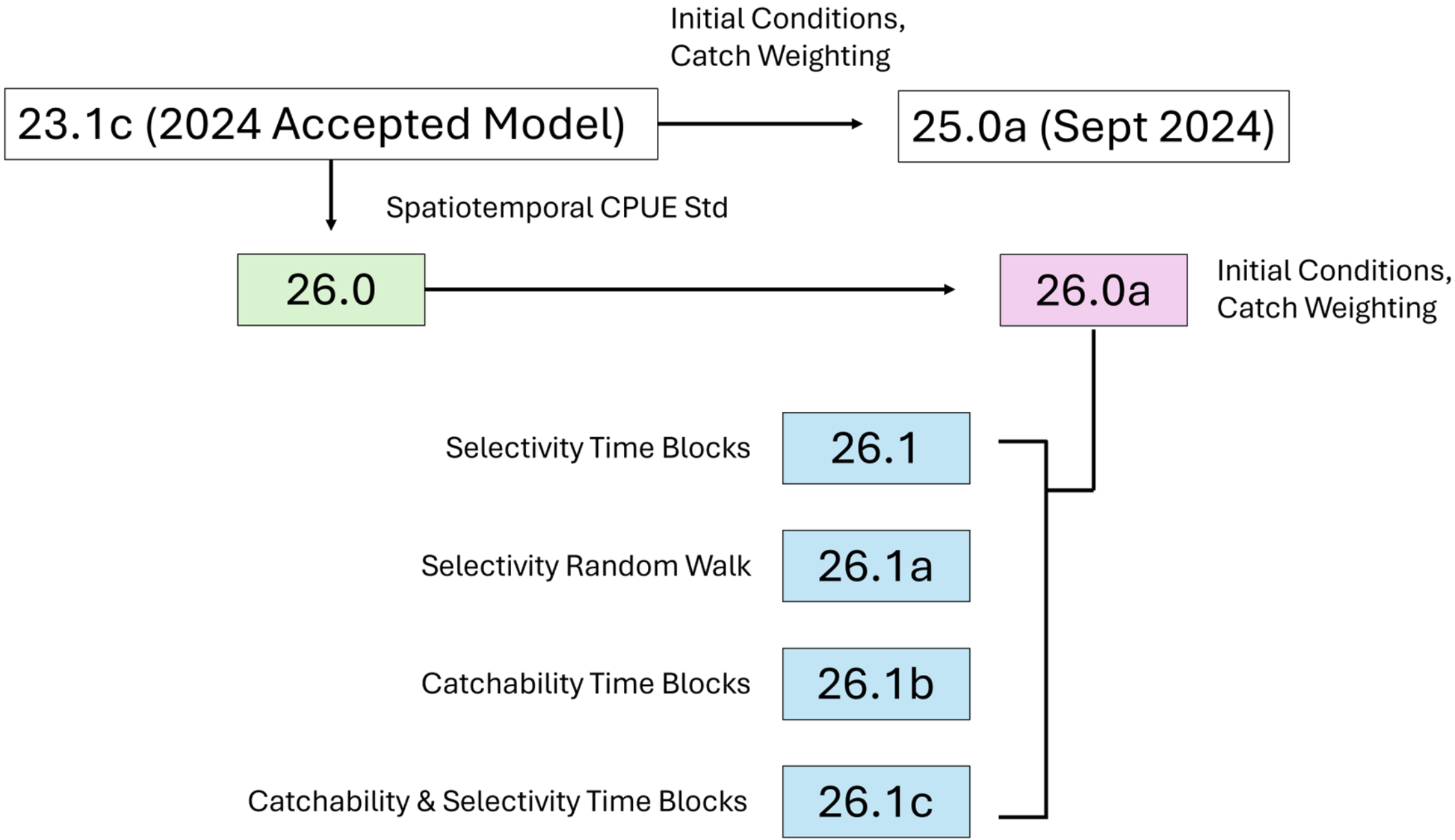




23.1c
25.0a
26.0
26.0a






Initial Conditions,
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25.0a (Sept 2024)
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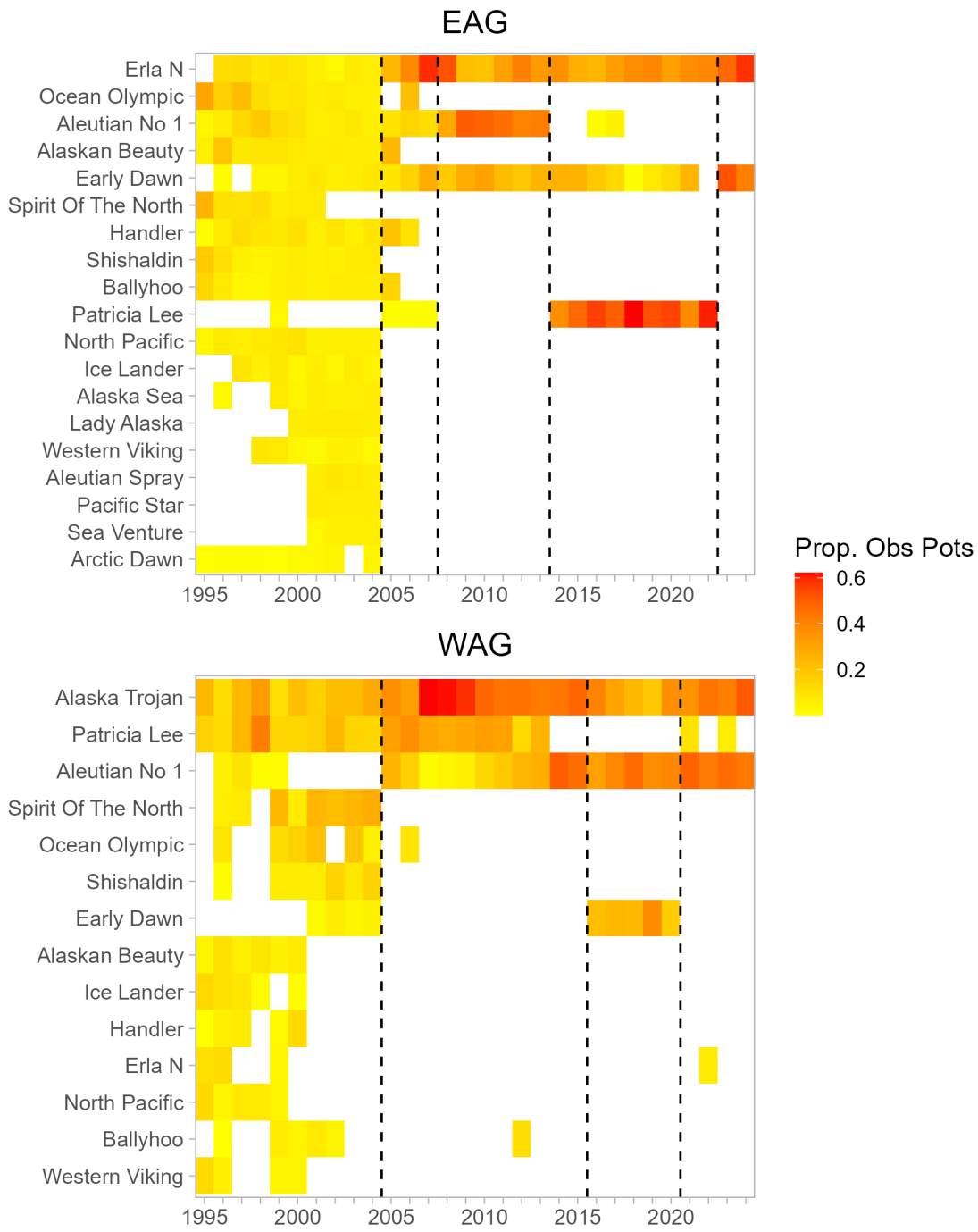
26.0
26.0a
Initial Conditions,
Catch Weighting
Selectivity Time Blocks
26.1
Selectivity Random Walk
26.1a
Catchability Time Blocks
26.1b
Catchability & Selectivity Time Blocks
26.1c

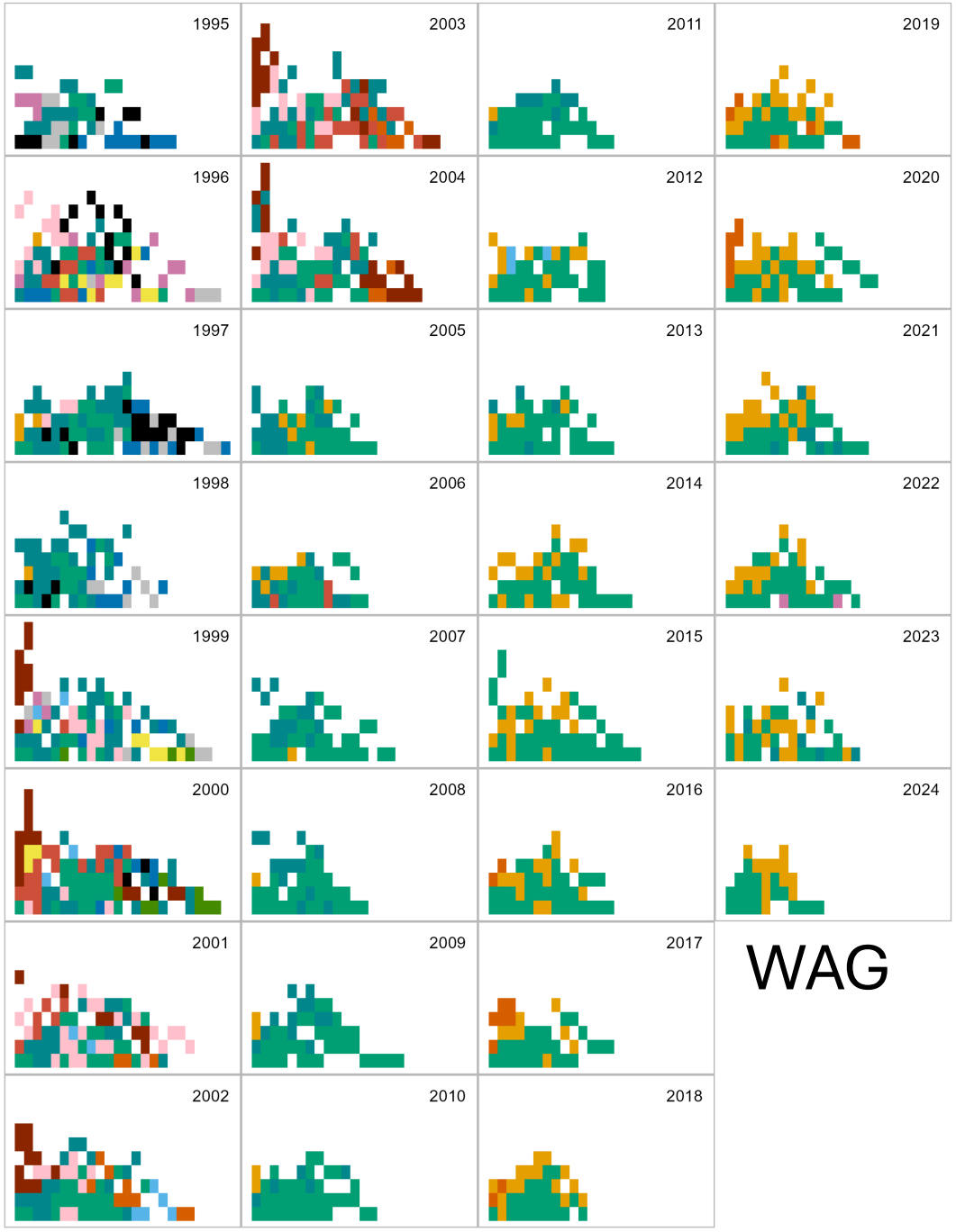
Time varying selectivity and/or catchability is ***likely*** result of changing fleet

Pre-rationalization = many participants, less specific/selective behavior

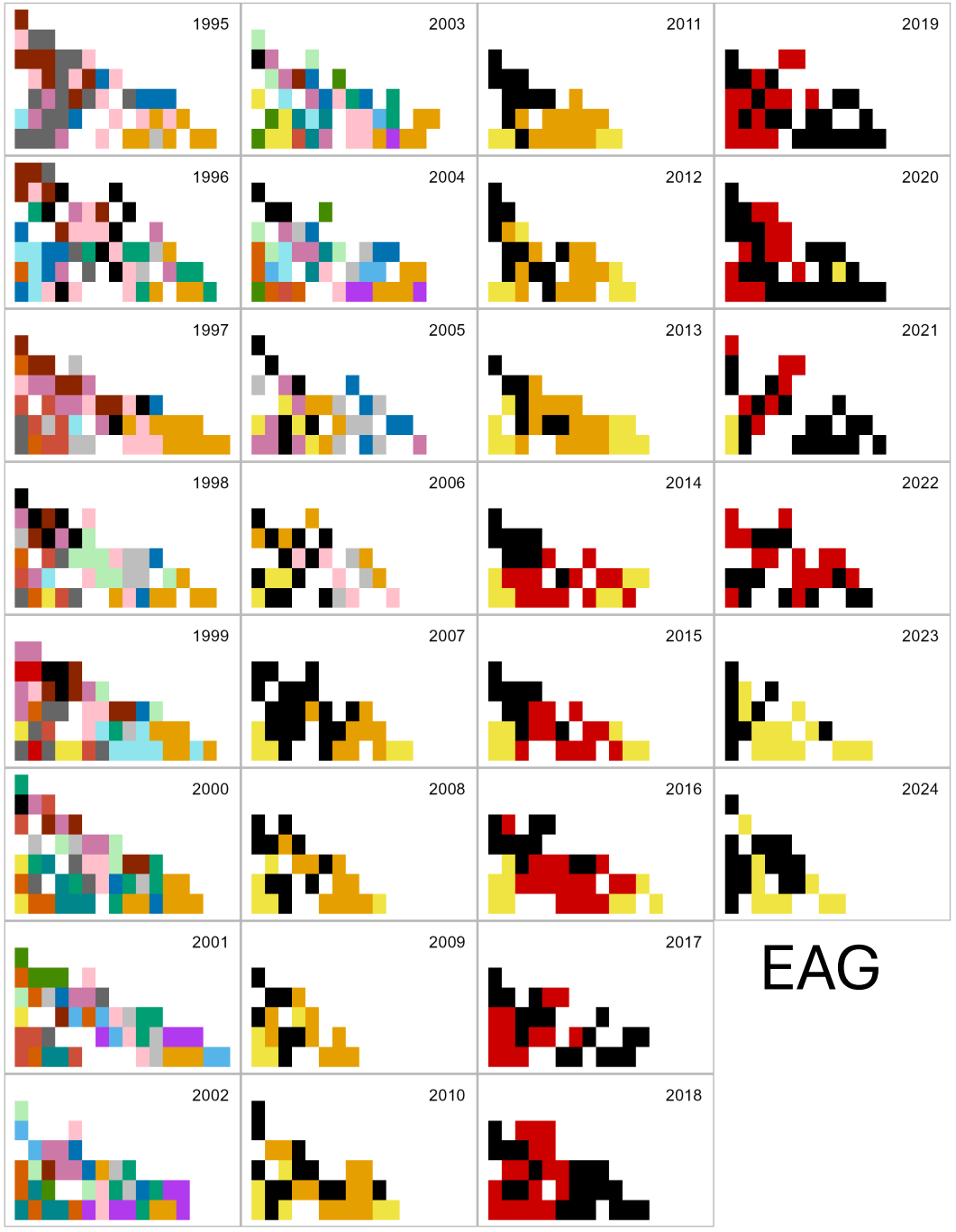
Fleet consolidation post-rationalization happened over several time blocks

EAG	WAG
2005 - 2007	2005 - 2015
2008 - 2013	2016 - 2020
2014 - 2022	2021 - 2024
2023 - 2024	

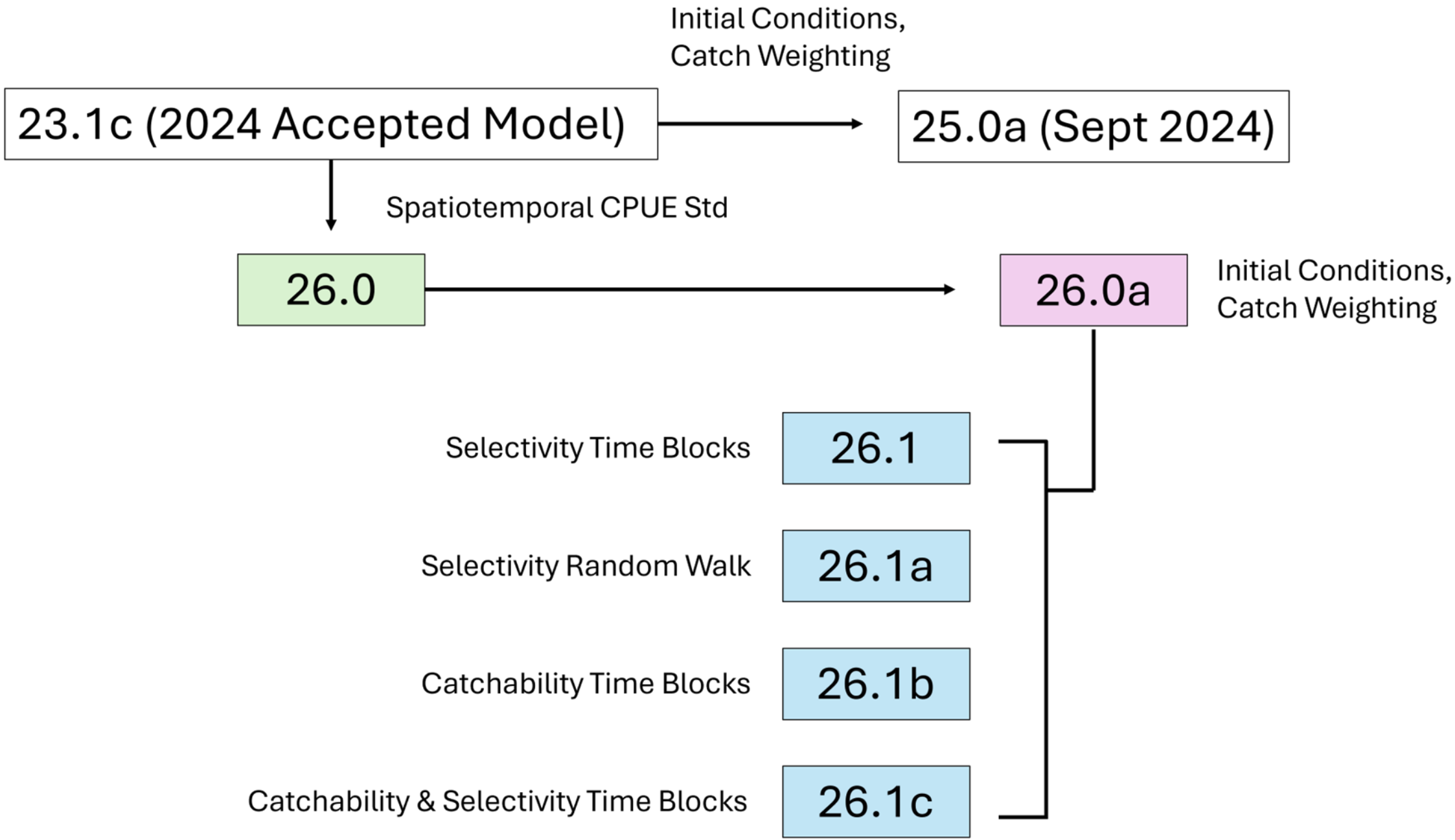


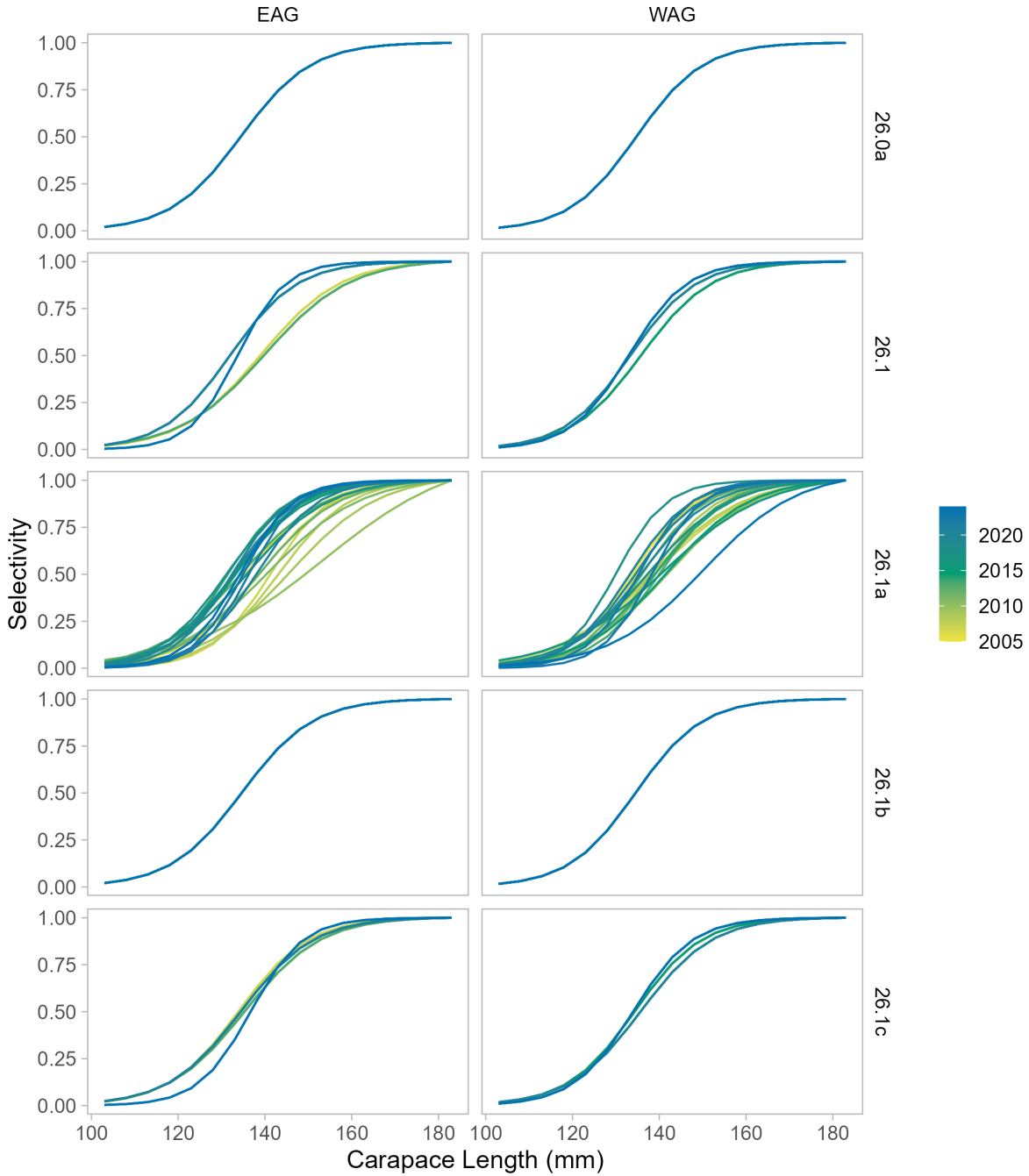

1995
2003
2011
2019
1996
2004
2012
2020
1997
2005
2013
2021
1998
2006
2014
2022
1999
2007
2015
2023
2000
2008
2016
2024
2001
2009
2017
2002
2010
2018

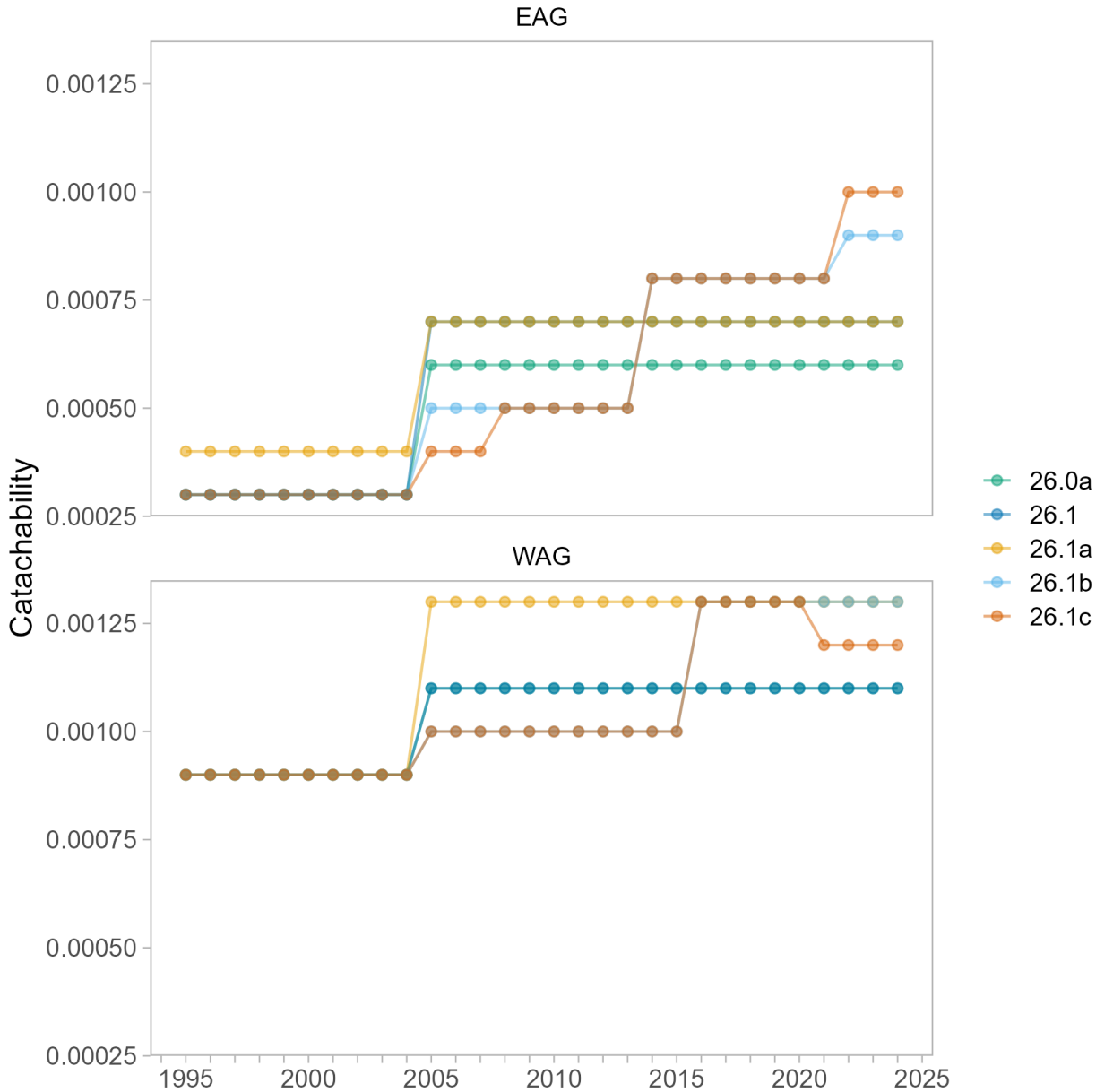
WAG


1995
2003
2011
2019
1996
2004
2012
2020
1997
2005
2013
2021
1998
2006
2014
2022
1999
2007
2015
2023
2000
2008
2016
2024
2001
2009
2017
2002
2010
2018

EAG

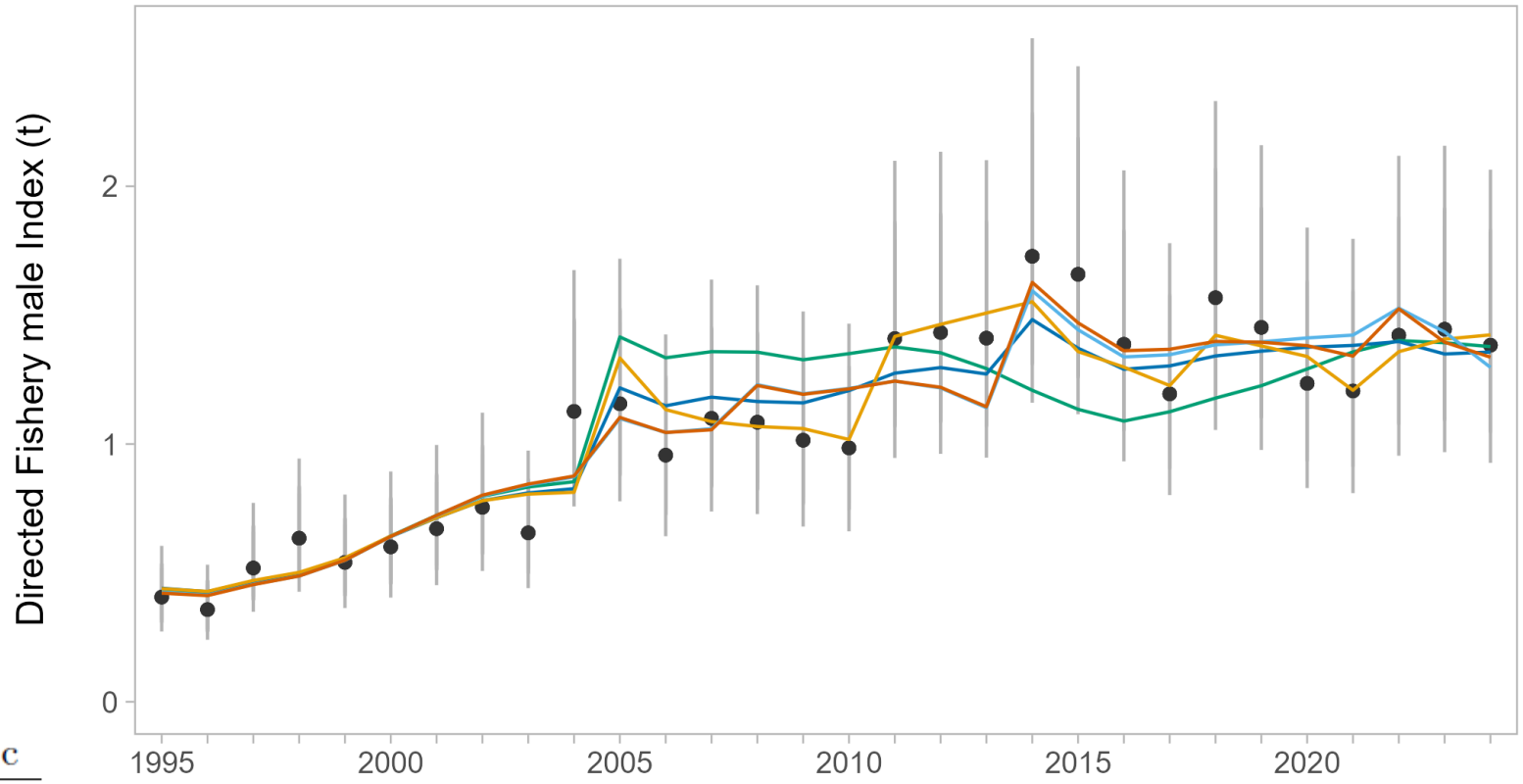

Initial Conditions,
Catch Weighting
23.1c (2024 Accepted Model)
25.0a (Sept 2024)
Spatiotemporal CPUE Std
26.0
26.0a
Initial Conditions,
Catch Weighting
Selectivity Time Blocks
26.1
Selectivity Random Walk
26.1a
Catchability Time Blocks
26.1b
Catchability & Selectivity Time Blocks
26.1c

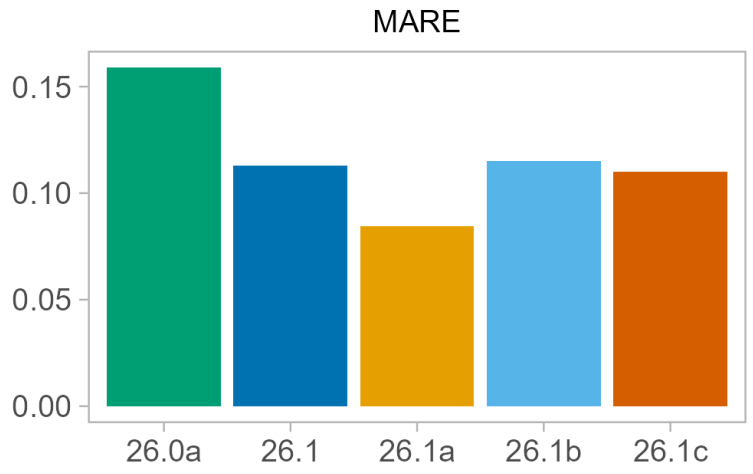

EAG
WAG
26.0a
26.1
26.1a
26.1b
26.1c
Selectivity
1.00
0.75
0.50
0.25
0.00
100
120
140
160
180
Carapace Length (mm)
2020
2015
2010
2005

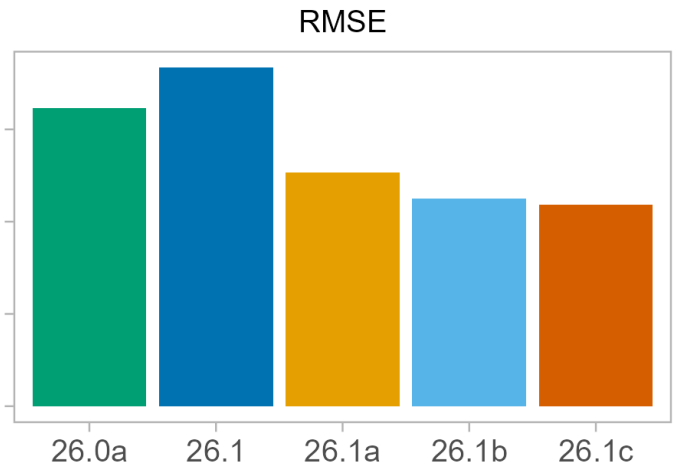

EAG
WAG
Catachability
0.00125
0.00100
0.00075
0.00050
0.00025
1995
2000
2005
2010
2015
2020
2025
26.0a
26.1
26.1a
26.1b
26.1c

EAG

Subdistrict	26.0a	26.1	26.1a	26.1b	26.1c
EAG	0.20	0.13	0.12	0.14	0.13
WAG	0.11	0.10	0.04	0.10	0.10

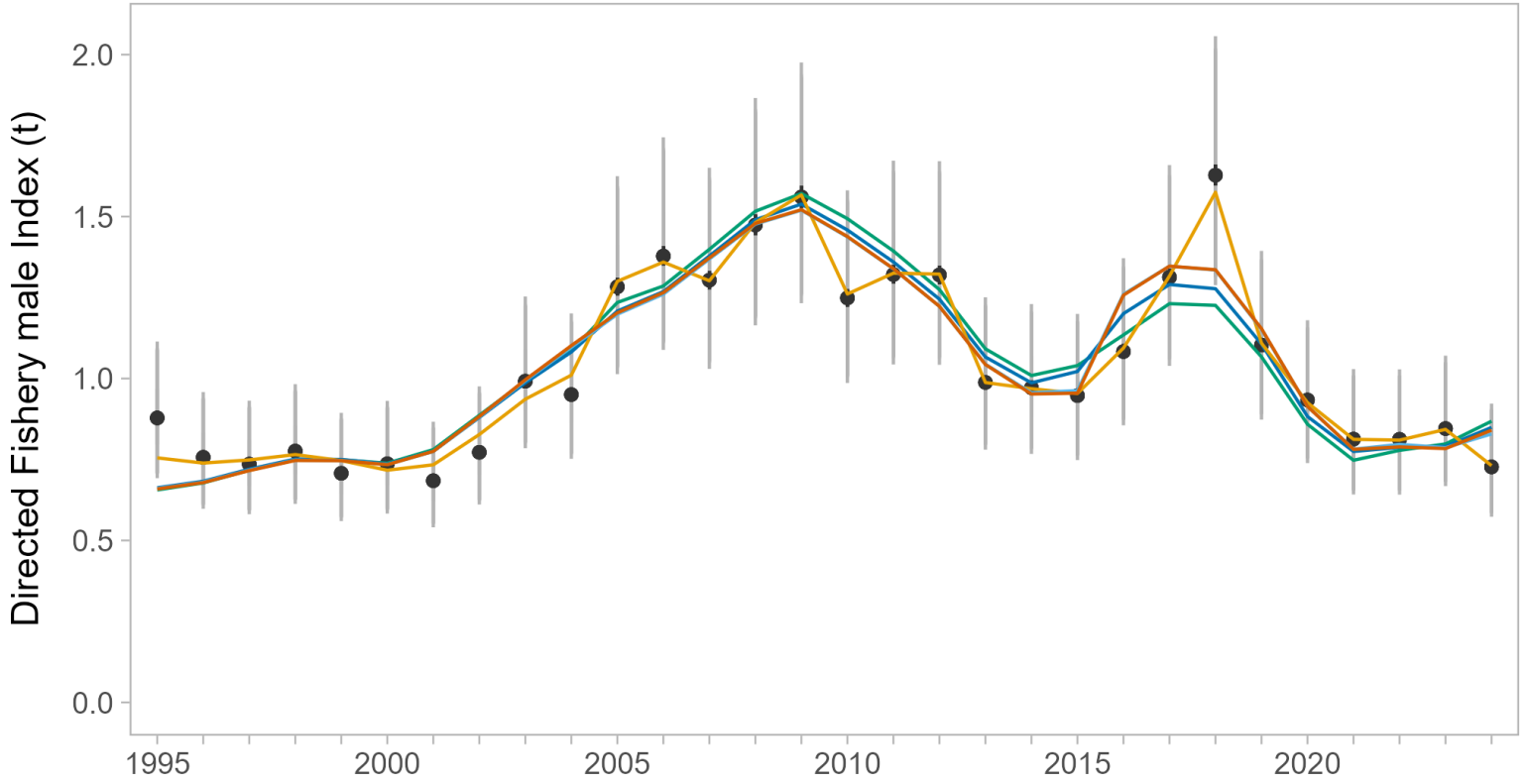


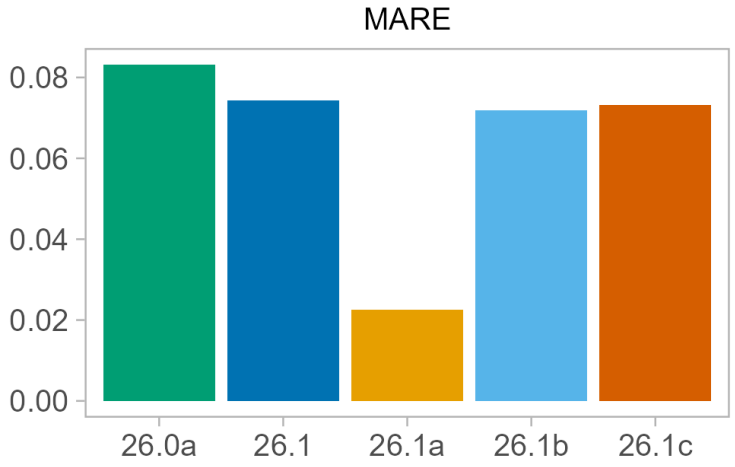


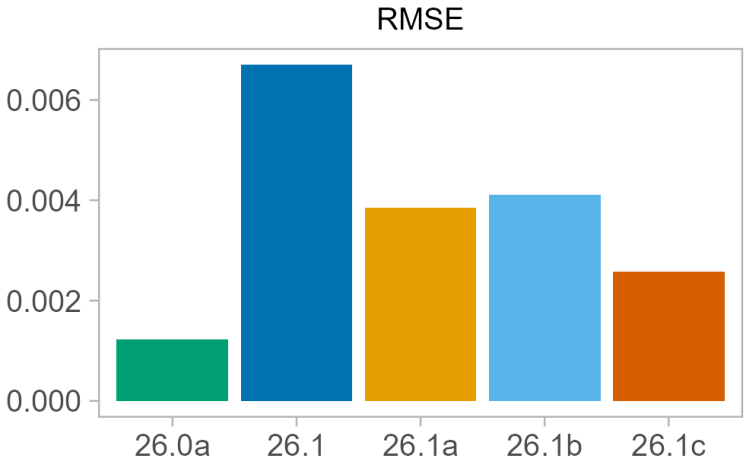


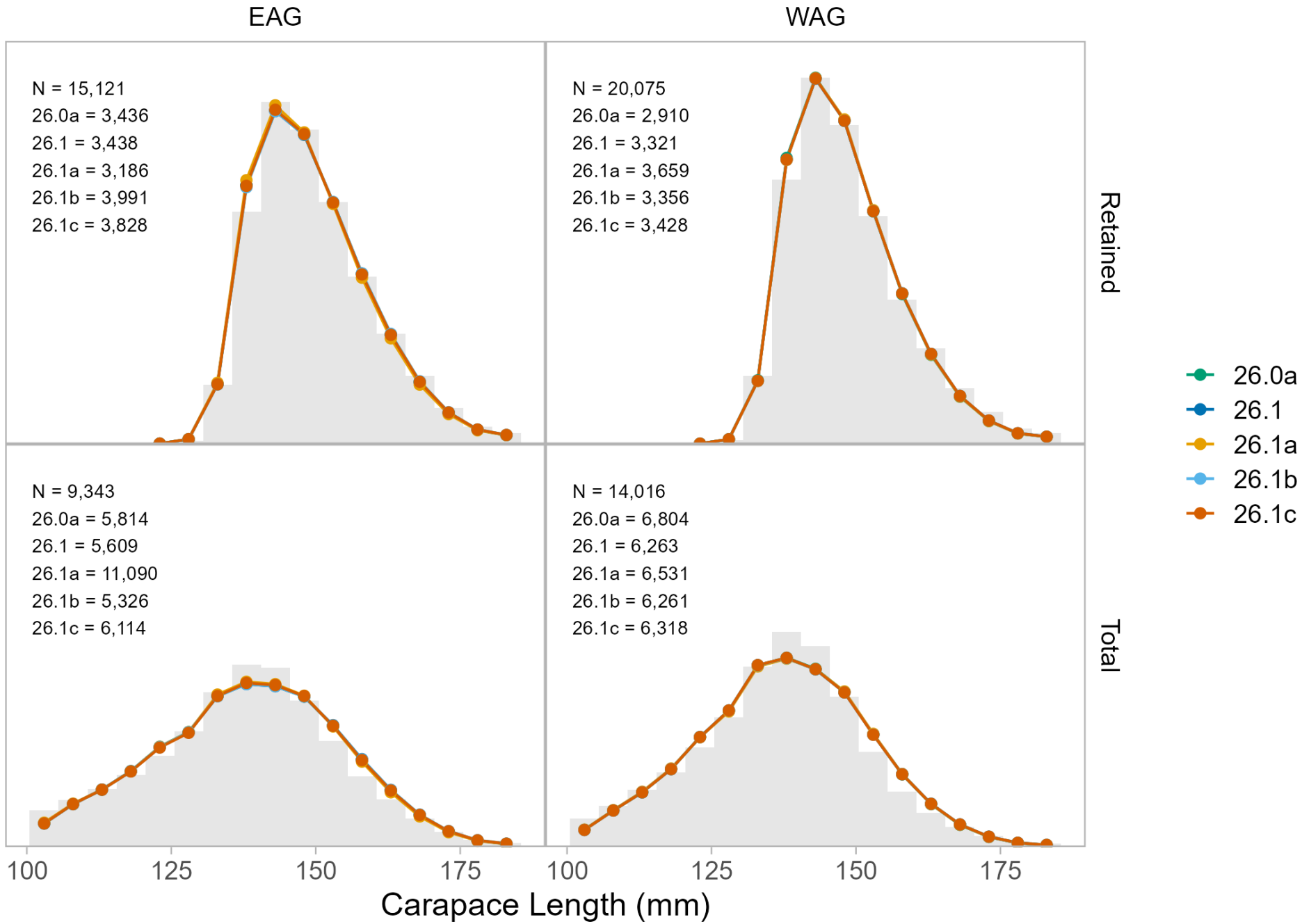
WAG

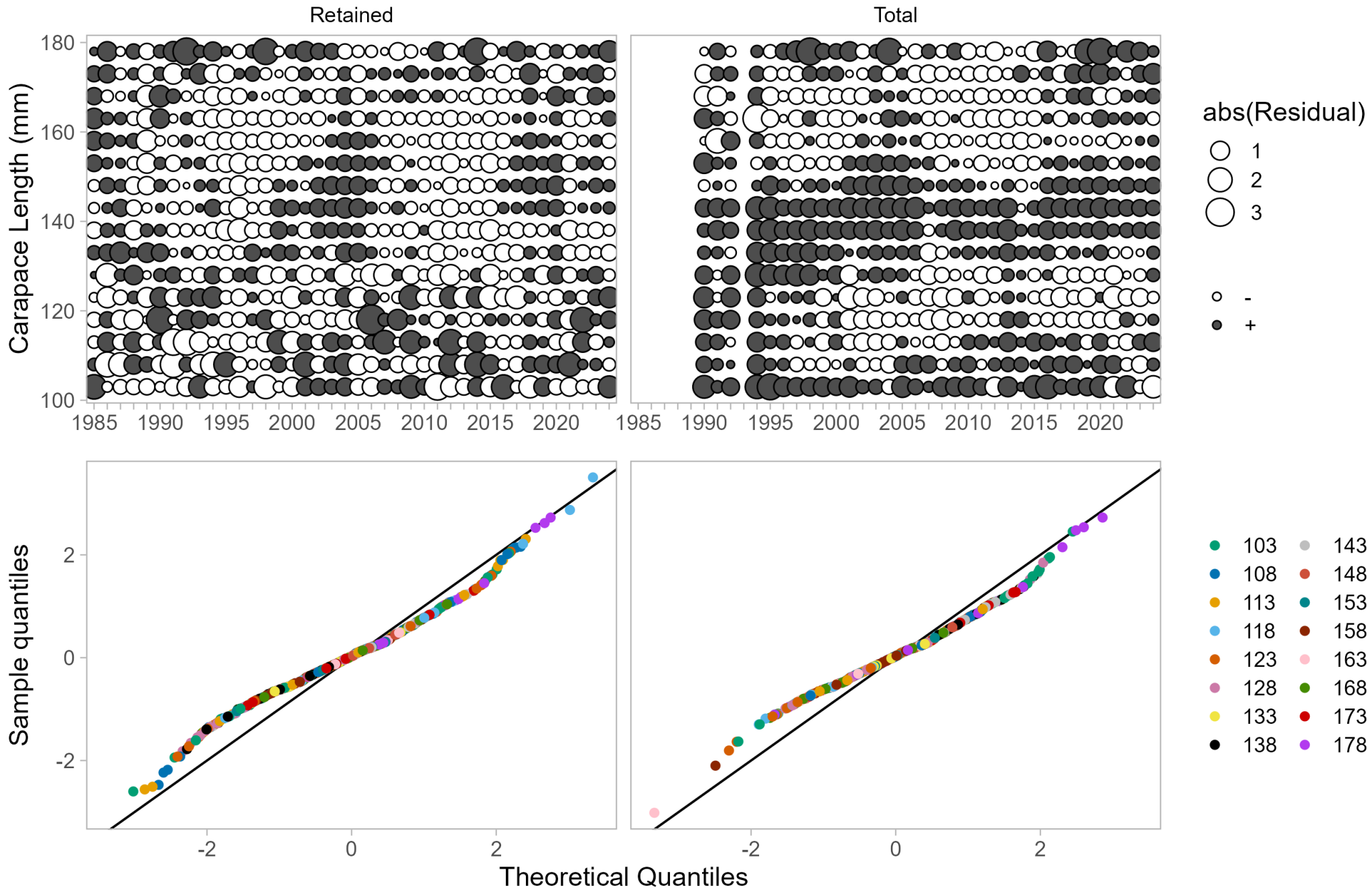
Subdistrict	26.0a	26.1	26.1a	26.1b	26.1c
EAG	0.20	0.13	0.12	0.14	0.13
WAG	0.11	0.10	0.04	0.10	0.10

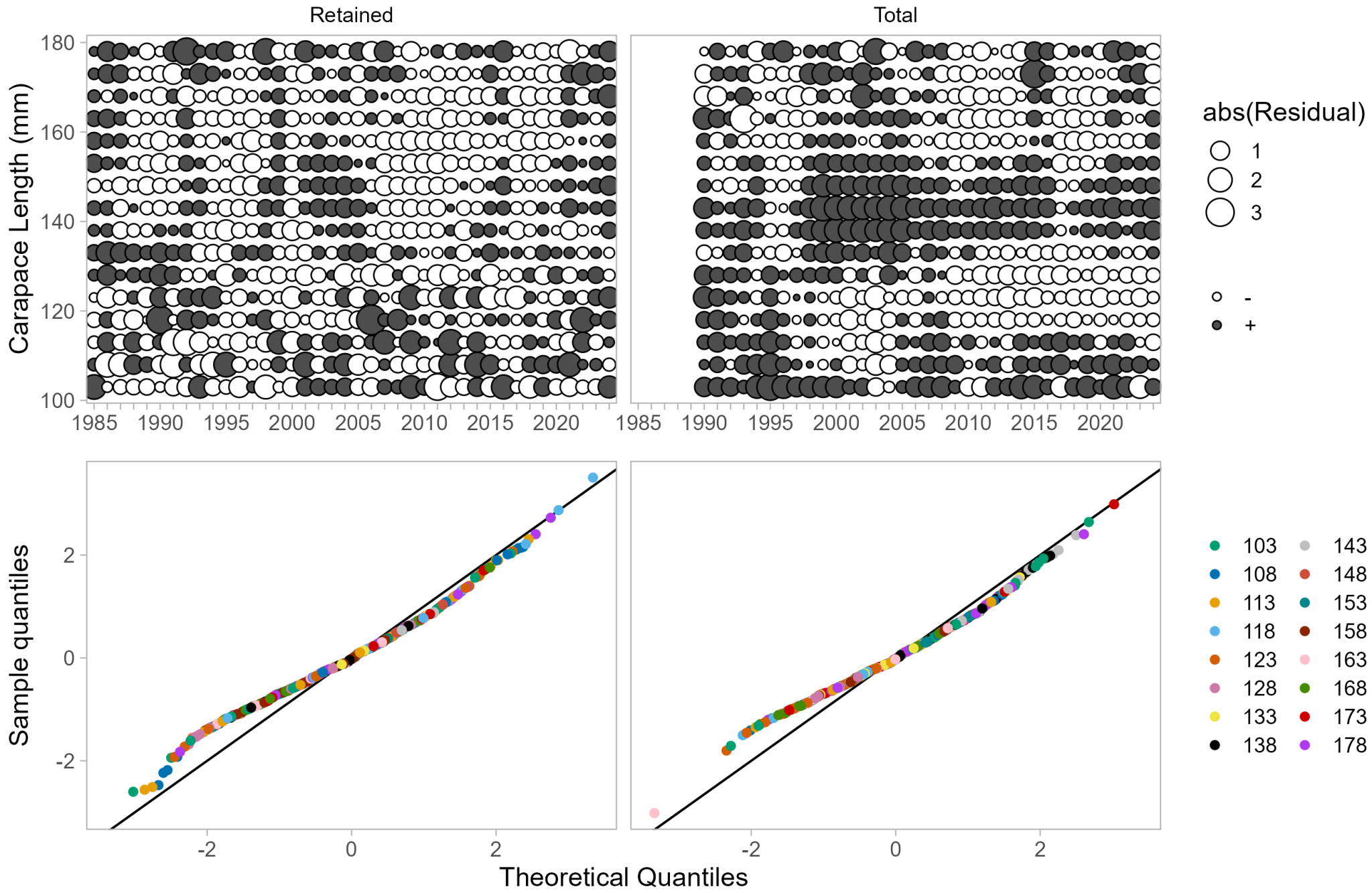







EAG
WAG
N = 15,121
26.0a = 3,436
26.1 = 3,438
26.1a = 3,186
26.1b = 3,991
26.1c = 3,828
N = 20,075
26.0a = 2,910
26.1 = 3,321
26.1a = 3,659
26.1b = 3,356
26.1c = 3,428
N = 9,343
26.0a = 5,814
26.1 = 5,609
26.1a = 11,090
26.1b = 5,326
26.1c = 6,114
N = 14,016
26.0a = 6,804
26.1 = 6,263
26.1a = 6,531
26.1b = 6,261
26.1c = 6,318
Retained
Total
100
125
150
175
Carapace Length (mm)
26.0a
26.1
26.1a
26.1b
26.1c


Retained
Total
Carapace Length (mm)
180
160
140
120
100
1985
1990
1995
2000
2005
2010
2015
2020
abs(Residual)
1
2
3
-
+
Sample quantiles
2
0
-2
Theoretical Quantiles
103
108
113
118
123
128
133
138
143
148
153
158
163
168
173
178

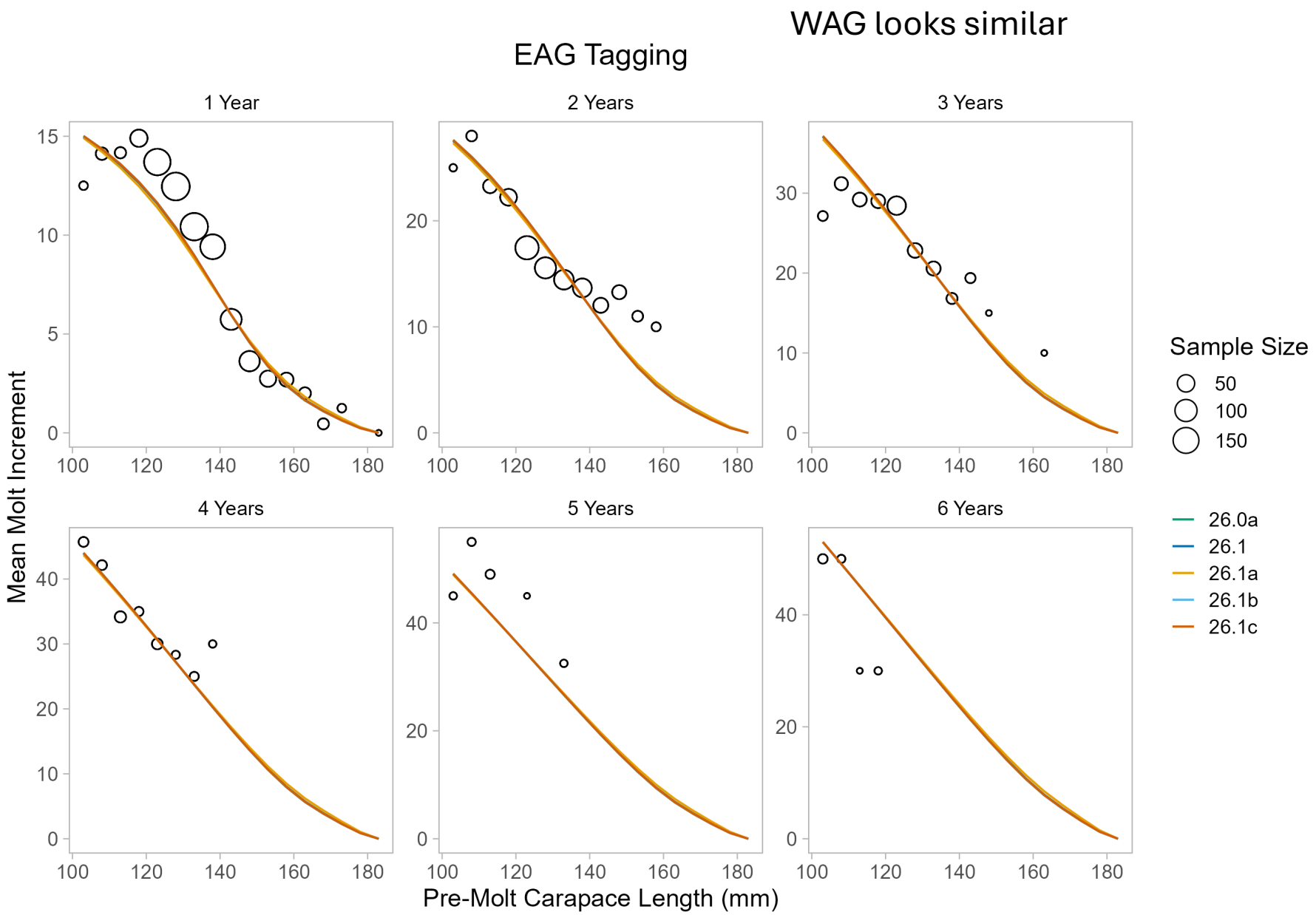

Retained
Total
Carapace Length (mm)
180
160
140
120
100
1985
1990
1995
2000
2005
2010
2015
2020
abs(Residual)
1
2
3
-
+
Sample quantiles
2
0
-2
Theoretical Quantiles
103
108
113
118
123
128
133
138
143
148
153
158
163
168
173
178

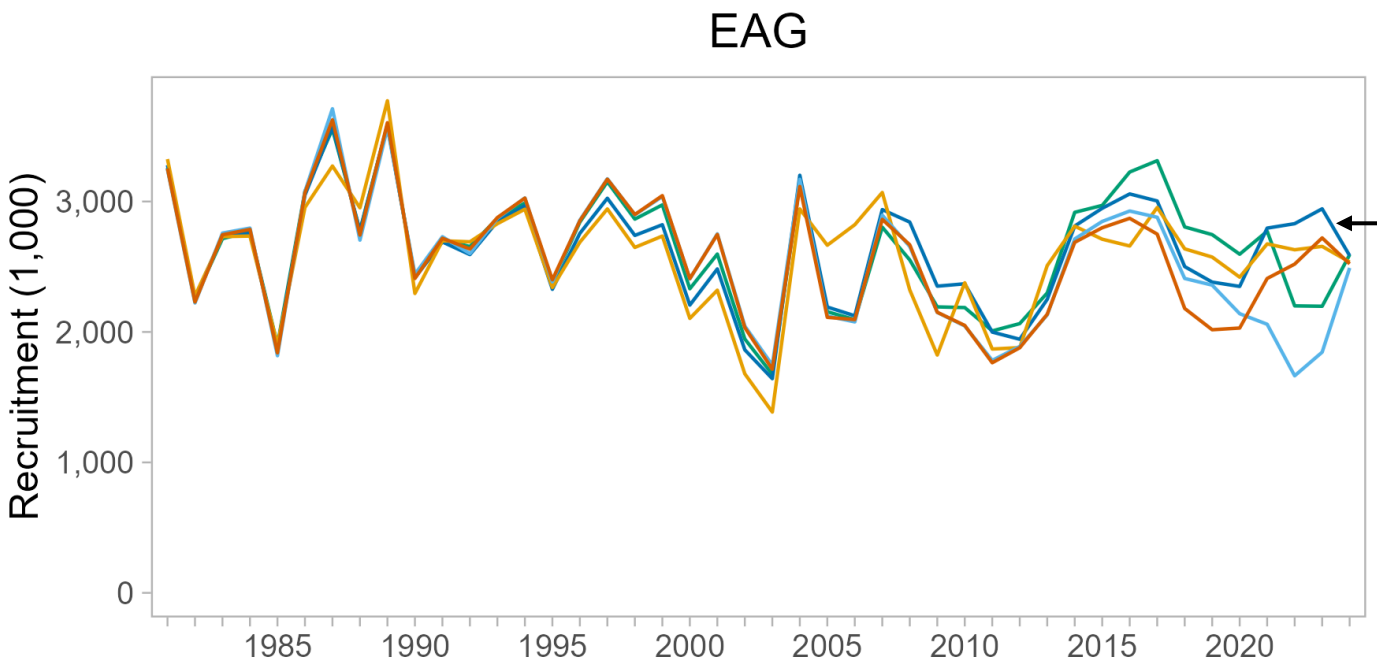
All Returns specified as pre-rat

Need original data

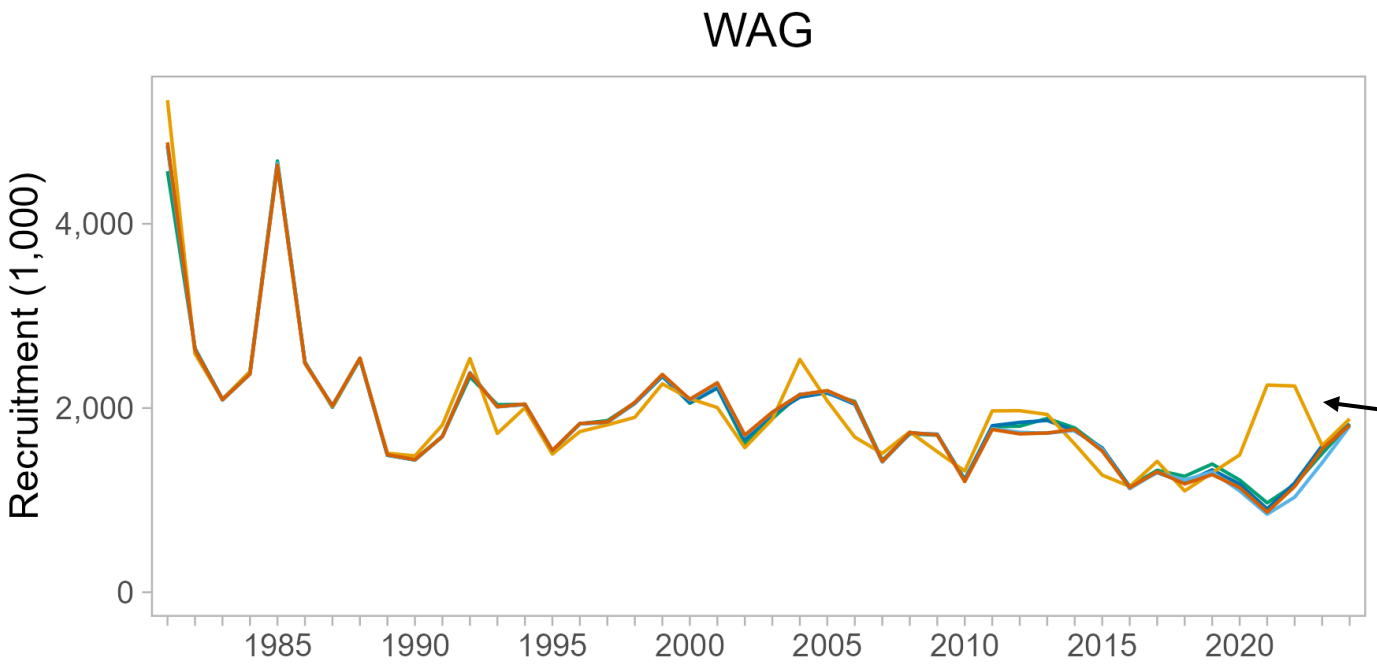
Revisit growth function?

WAG looks similar



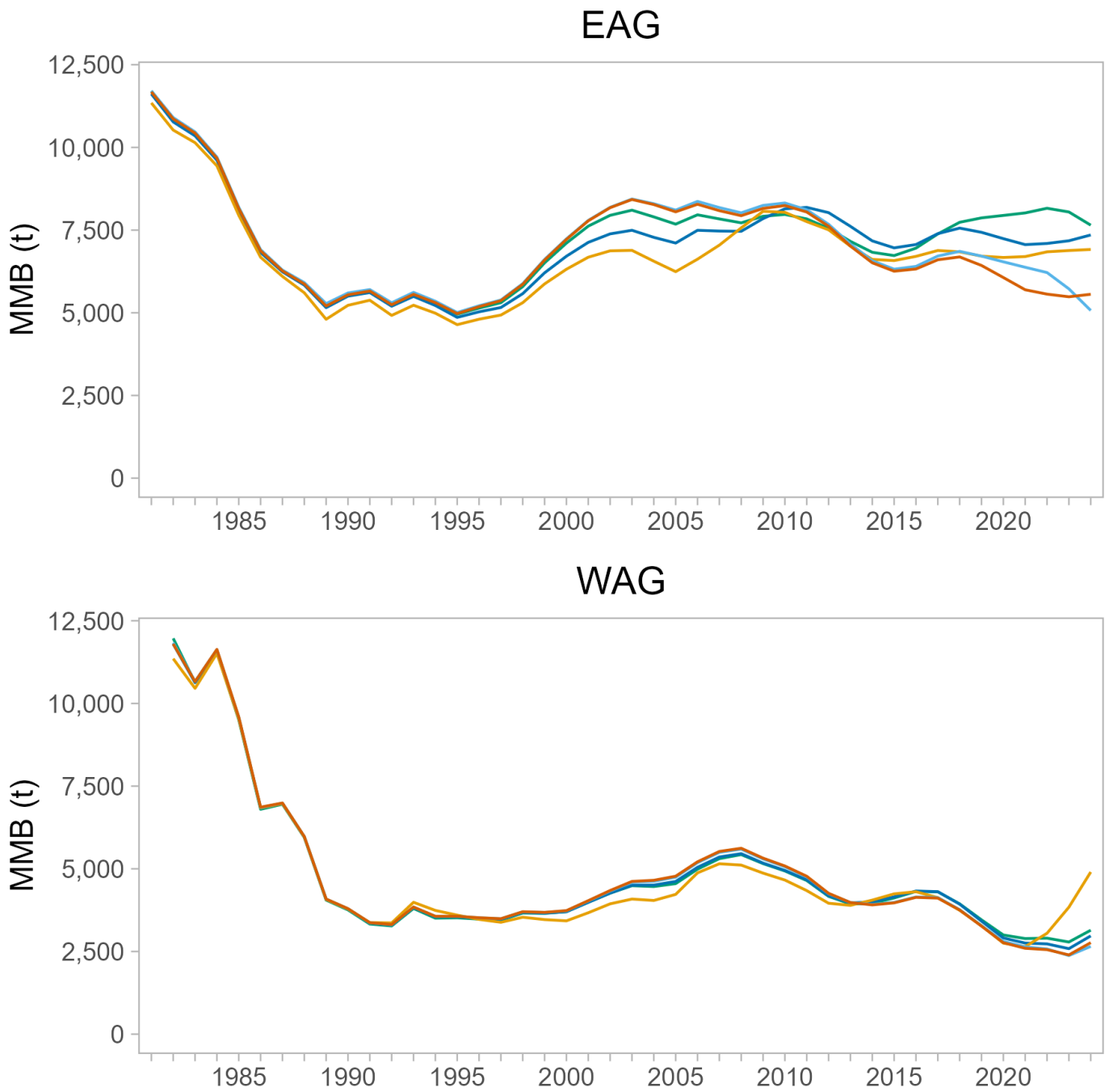


Models w/ time varying slx diverge here



26.0a
26.1
26.1a
26.1b
26.1c

Likely because slx is so flexible



*Retrospective analysis not working with *q* blocks

Will run 'manually' in May if still unresolved

EAG

Model	MMB (t)	$B_{35\%}$ (t)	$\frac{MMB}{B_{35\%}}$	$\bar{R}_{1987-2021}$	$F_{35\%}$	F_{OFL}	OFL (t)
26.0	6,671	6,737	0.99	2,695	0.51	0.51	2,276
26.0a	6,843	6,707	1.02	2,670	0.52	0.52	2,315
26.1	7,268	6,575	1.11	2,618	0.50	0.50	2,137
26.1a	6,801	6,491	1.05	2,580	0.51	0.51	2,006
26.1b	5,250	6,548	0.80	2,606	0.52	0.41	1,234
26.1c	6,100	6,472	0.94	2,576	0.53	0.49	1,493

WAG

Model	MMB (t)	$B_{35\%}$ (t)	$\frac{MMB}{B_{35\%}}$	$\bar{R}_{1987-2021}$	$F_{35\%}$	F_{OFL}	OFL (t)
26.0	3,615	4,520	0.80	1,811	0.52	0.41	791
26.0a	3,531	4,518	0.78	1,803	0.54	0.41	747
26.1	3,476	4,509	0.77	1,798	0.52	0.39	686
26.1a	4,819	4,493	1.07	1,785	0.58	0.58	1,404
26.1b	3,176	4,499	0.71	1,794	0.53	0.36	565
26.1c	3,337	4,500	0.74	1,794	0.53	0.38	611

Jittering model 26.1 and 26.1b

- For base model see 2025 final assessment – no issues
- EAG, all jitter runs converge to MLE – explore jitter sd > 0.3 in final assessment
- WAG, identified one other minimum, > 75% of runs converge to MLE

Author Recommendations

Risk in assigning variability to processes erroneously (i.e. trading or adding to misspecification) (Fisch et al., 2023; Szuwalksi et al., 2018)

- Strong case for vessel dynamics varying assumptions about fishing process

Time blocks feel fairly subjective

- Less risk when correct process is varied, but overparameterized (Cronin-Fine And Punt 2021; Stewart and Monnahan 2017)

Diagnostics lacking here

- Case could be made for either selectivity or catchability
- **Bring models 23.1c, 26.0a, 26.1, and 26.1b to final assessment**

SSC 2025: Combined OFL Calculation

SSC suggested approach:

1. Add MMB and B_{35} by area
2. Apply cumulative stock status to F_{OFL} control rule using area specific F_{35}
3. Compute OFL and sum

Suggested by CPT/SSC in 2017, not used from 2018 onward (from what I can tell from past SAFEs and NPFMC motions)

Subdistrict	MMB (t)	$B_{35\%}$ (t)	Status	$F_{35\%}$	F_{OFL}	Combined Status	F_{OFL} (Combined)
EAG	6,879	6,730	1.022	0.515	0.515	0.928	0.474
WAG	3,570	4,530	0.788	0.514	0.393	0.928	0.473

Combined OFL Calculation

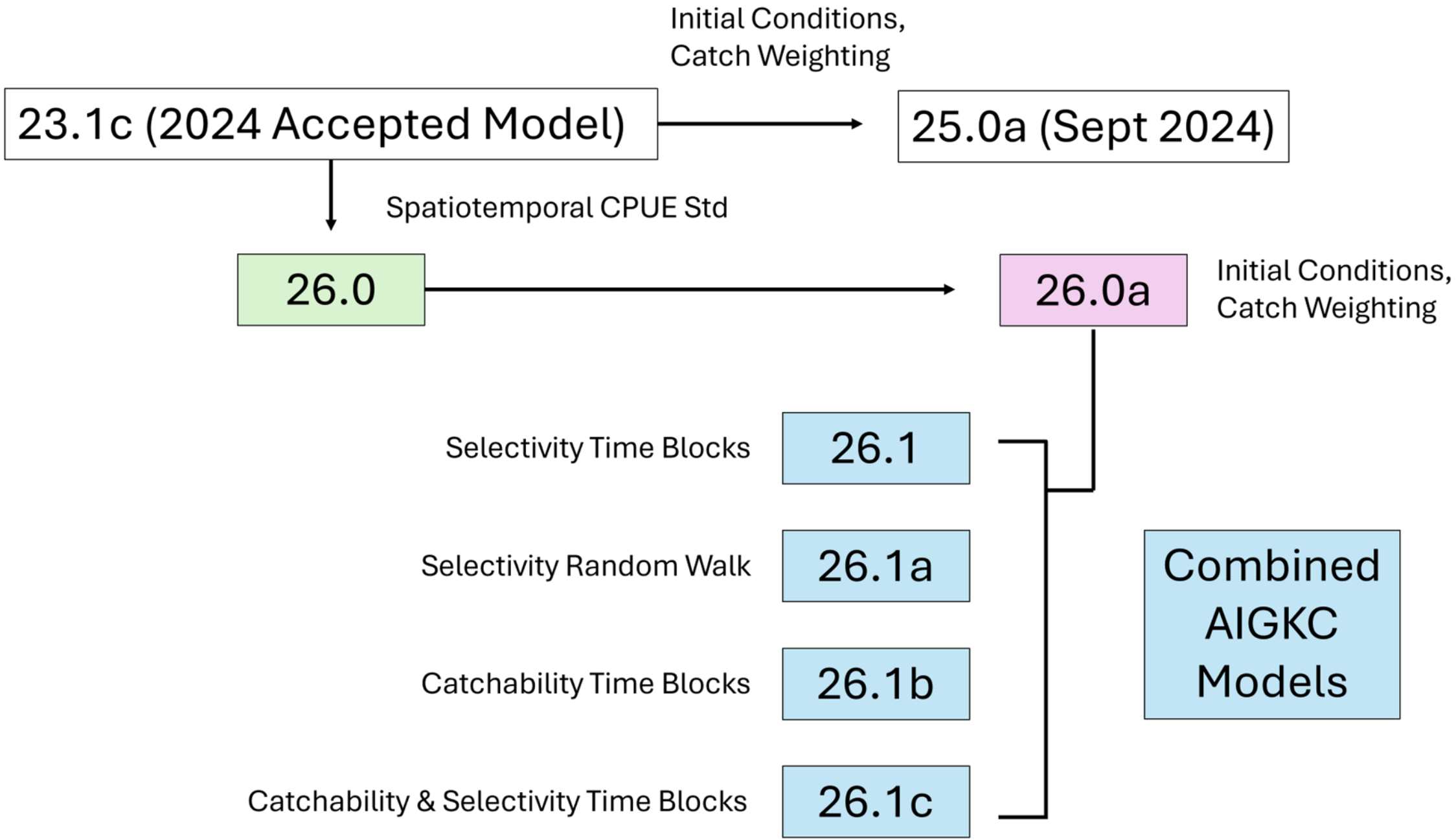
Subdistrict	MMB (t)	$B_{35\%}$ (t)	Status	$F_{35\%}$	F_{OFL}	Combined Status	F_{OFL} (Combined)
EAG	6,879	6,730	1.022	0.515	0.515	0.928	0.474
WAG	3,570	4,530	0.788	0.514	0.393	0.928	0.473

ADF&G manages subdistricts largely independently

- Harvest strategy exploitation rate on MMB (EAG 15%; WAG 20%)
- Separate TACs, separate vessel participation

Suggested Approach applies surplus in EAG to harvest opportunity in WAG

- Subdistrict specific reference points may warrant caution as population dynamics continue to diverge
- This approach *is* more akin to what a combined model would produce


Initial Conditions,
Catch Weighting
23.1c (2024 Accepted Model)
25.0a (Sept 2024)
Spatiotemporal CPUE Std
26.0
26.0a
Initial Conditions,
Catch Weighting
Selectivity Time Blocks
26.1
Selectivity Random Walk
26.1a
Catchability Time Blocks
26.1b
Catchability & Selectivity Time Blocks
26.1c
Combined AIGKC Models

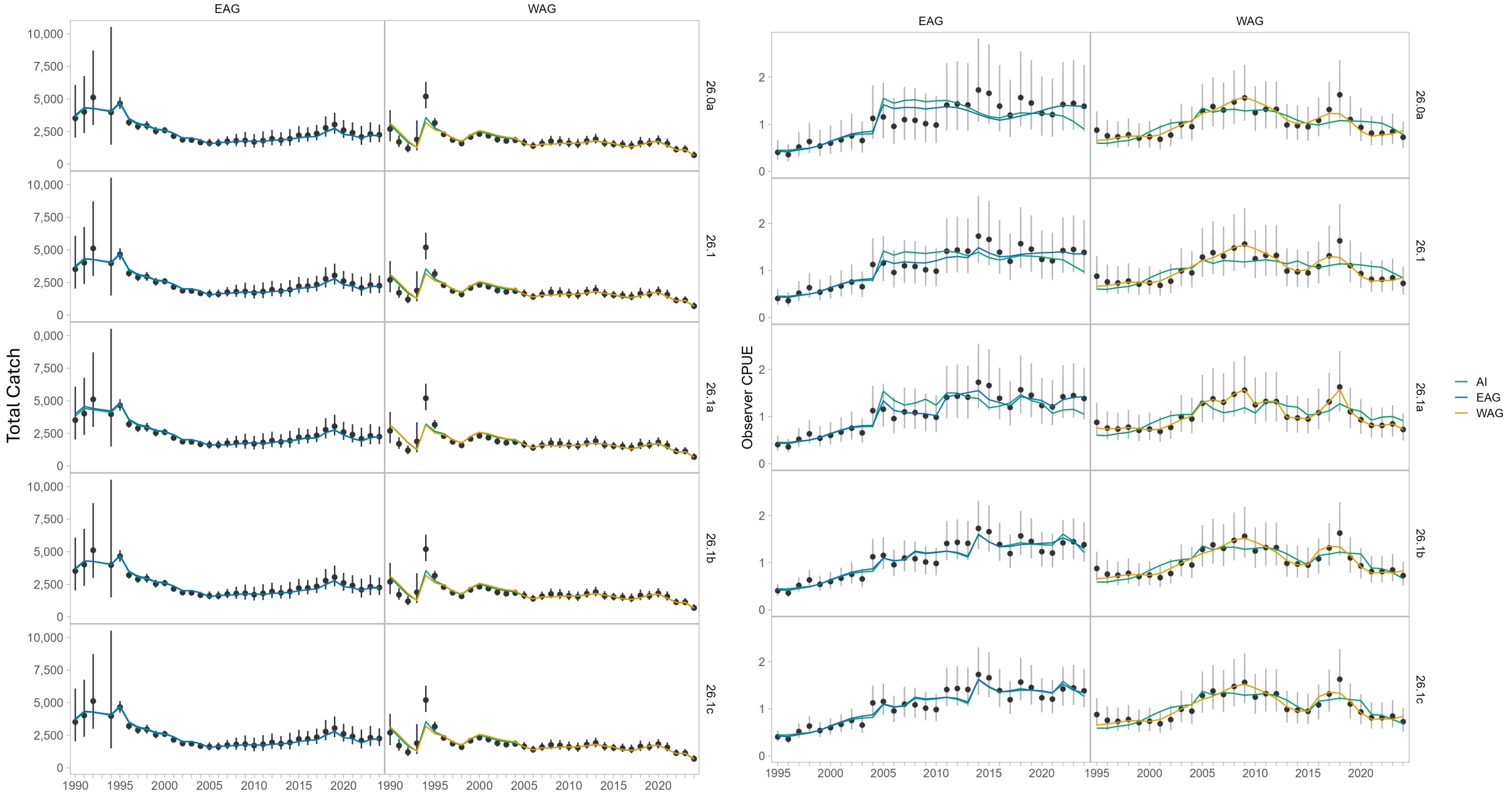
Combined Aleutian Islands Model

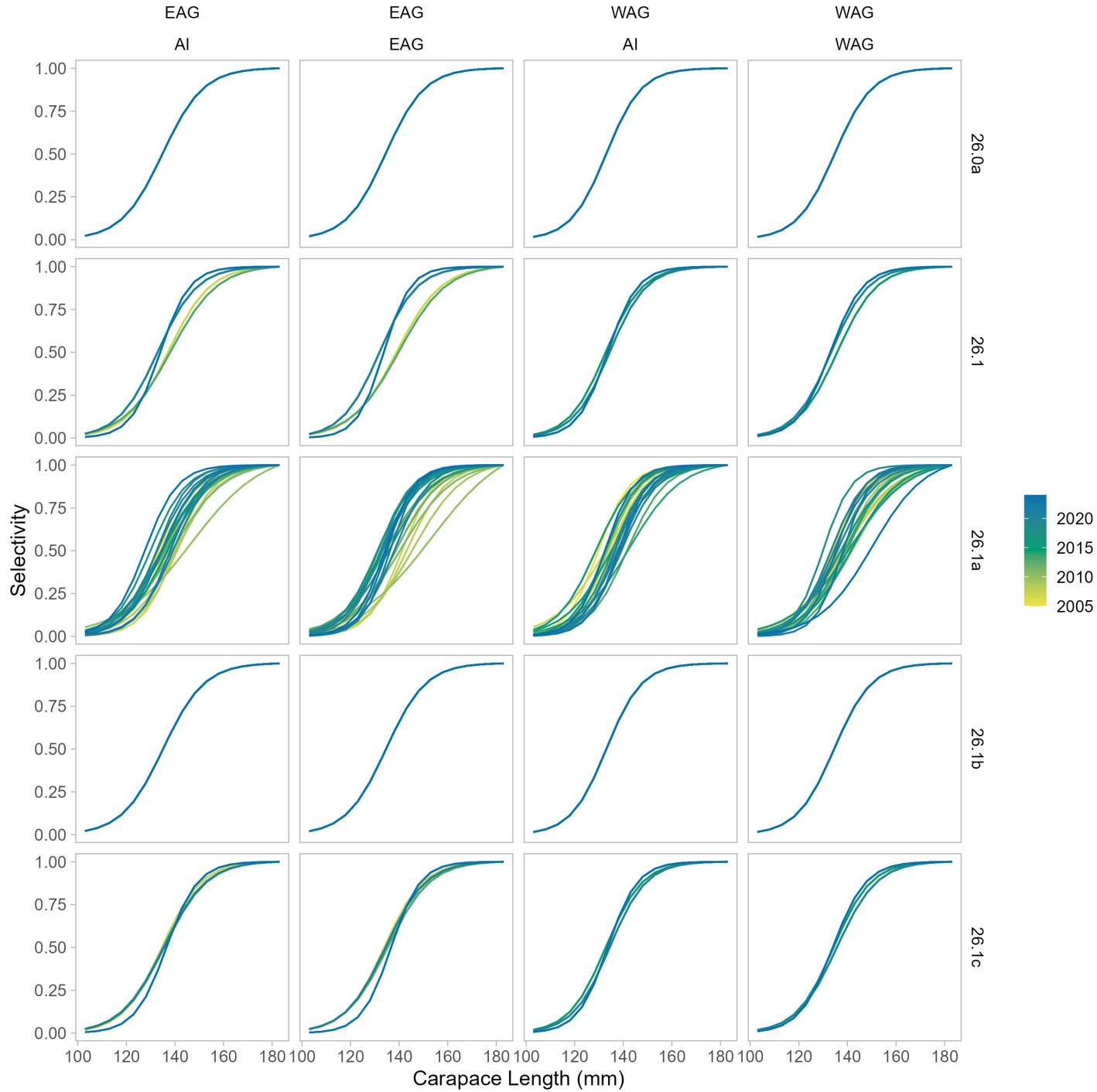
GMACS does not allow area stratification and subpopulation dynamics

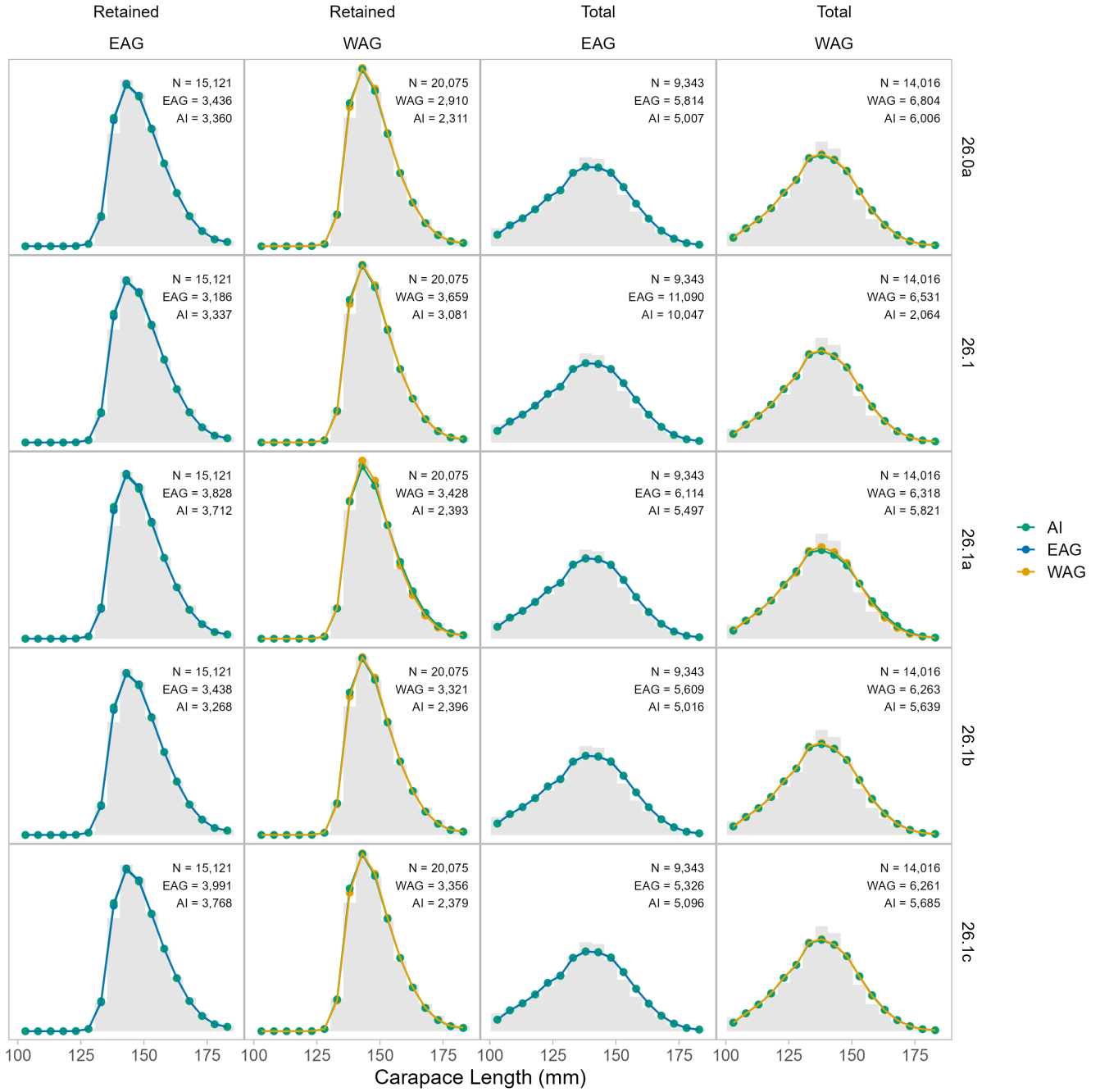
Stop-gap solution = use sex slot of framework in place of area – (two area model without migration)

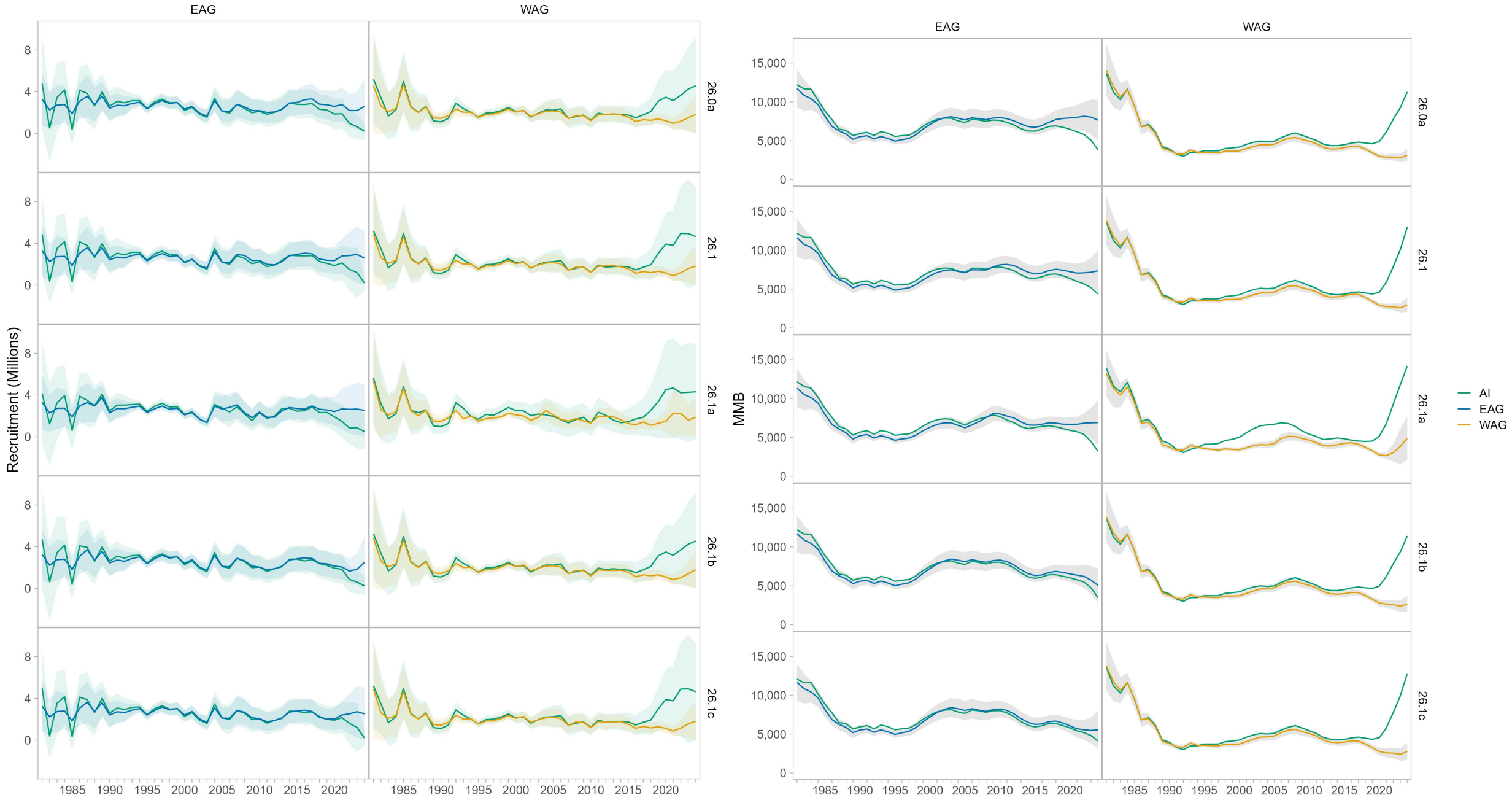
Still small issues:

- Sexes cannot share growth function, data
- Bycatch data must be combined


EAG
WAG
Total Catch
Observer CPUE
26.0a
26.1
26.1a
26.1b
26.1c
AI
EAG
WAG
10,000
7,500
5,000
2,500
0
2
1
1990
1995
2000
2005
2010
2015
2020


EAG
AI
EAG
EAG
WAG
AI
WAG
WAG
26.0a
26.1
26.1a
26.1b
26.1c
Selectivity
1.00
0.75
0.50
0.25
0.00
100
120
140
160
180
Carapace Length (mm)
2020
2015
2010
2005


Retained
EAG
Retained
WAG
Total
EAG
Total
WAG
N = 15,121
EAG = 3,436
AI = 3,360
N = 20,075
WAG = 2,910
AI = 2,311
N = 9,343
EAG = 5,814
AI = 5,007
N = 14,016
WAG = 6,804
AI = 6,006
26.0a
N = 15,121
EAG = 3,186
AI = 3,337
N = 20,075
WAG = 3,659
AI = 3,081
N = 9,343
EAG = 11,090
AI = 10,047
N = 14,016
WAG = 6,531
AI = 2,064
26.1
N = 15,121
EAG = 3,828
AI = 3,712
N = 20,075
WAG = 3,428
AI = 2,393
N = 9,343
EAG = 6,114
AI = 5,497
N = 14,016
WAG = 6,318
AI = 5,821
26.1a
N = 15,121
EAG = 3,438
AI = 3,268
N = 20,075
WAG = 3,321
AI = 2,396
N = 9,343
EAG = 5,609
AI = 5,016
N = 14,016
WAG = 6,263
AI = 5,639
26.1b
N = 15,121
EAG = 3,991
AI = 3,768
N = 20,075
WAG = 3,356
AI = 2,379
N = 9,343
EAG = 5,326
AI = 5,096
N = 14,016
WAG = 6,261
AI = 5,685
26.1c
100
125
150
175
Carapace Length (mm)
AI
EAG
WAG


EAG
WAG
Recruitment (Millions)
MMB
26.0a
26.1
26.1a
26.1b
26.1c
AI
EAG
WAG
0
4
8
5,000
10,000
15,000
1985
1990
1995
2000
2005
2010
2015
2020

Combined Aleutian Islands Model

Bridging issue may be that data are specified as the same fleet?

Issue in estimating Rec sex ratio dev?

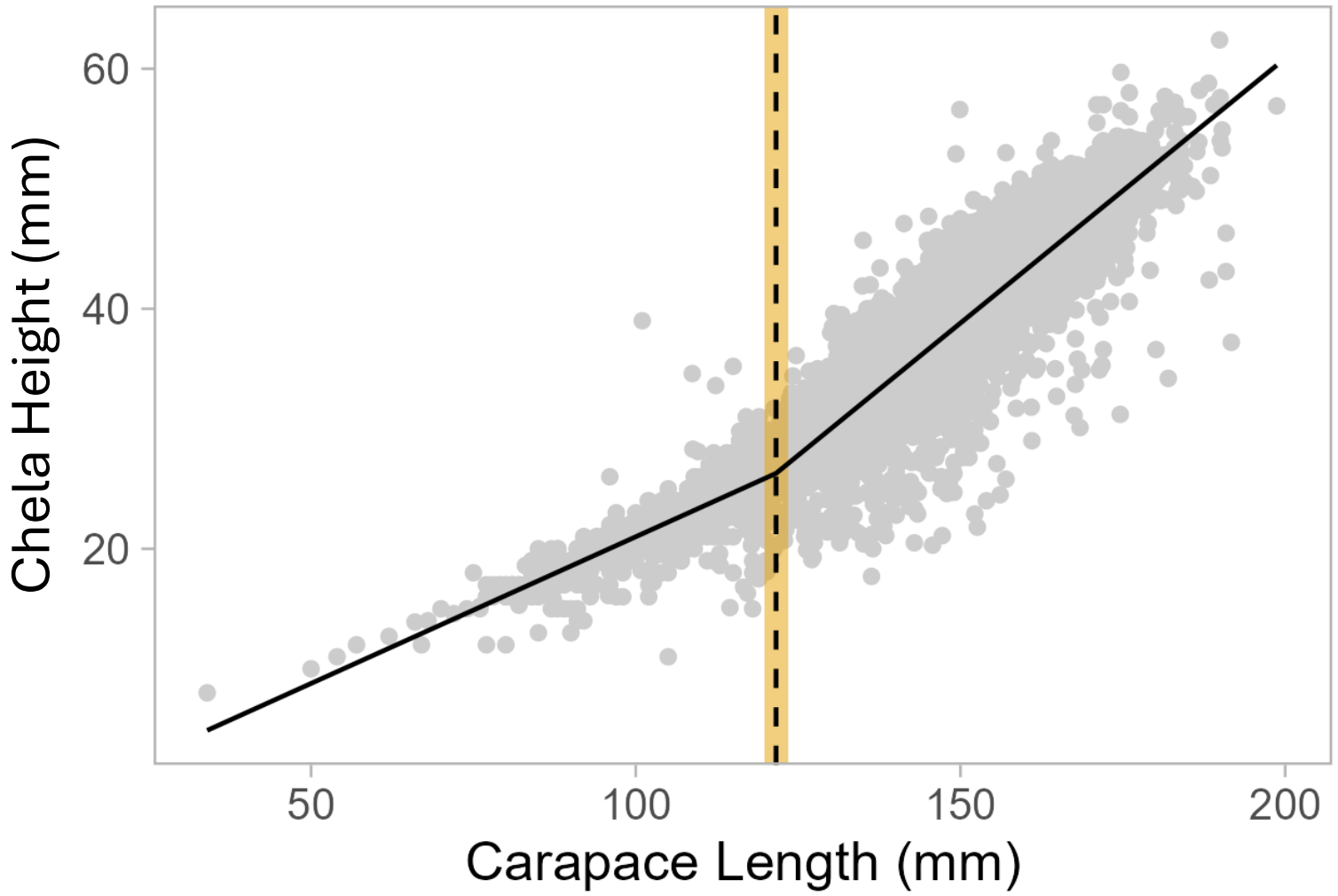
Need to just focus on one model scenario next assessment cycle

Asking for more direction on whether to prioritize this vs progress on subdistrict specific models

Appendix B: Size at Maturity

Study	Region	Data	N	SM (ψ)	CI (SE)
Jewett et al. (1985)	ln (CH / CL)	British Columbia	395	114	102.6-125.4
Otto and Cumminsky (1985)	ln (CH / CL)	Bowers Ridge	515	108.6	(2.6)
	ln (CH / CL)	Seguam Pass	775	120.8	(2.9)
Somerton and Otto (1986)	ln (CH / CL)	St. Matthew Is	205	92.0	87.3-96.7
	ln (CH / CL)	Pribilof Is.	1,866	107.0	97.9-116.0
	ln (CH / CL)	Aleutian Is.	299	130.0	122.2-137.8
Olson et al. (2018)	CH / CL	Lynn Canal	1,859	147.3	134.0-150.7
	CH / CL	Icy Strait	668	158.0	149.9-162.7
	CH / CL	Frederick Sound	398	131.9	120.3-181.0
	CH / CL	North Stephens Passage	2,294	137.6	131.0-141.0
	CH / CL	Mid-Chatham Strait	2,183	127.3	121.4-131.4
	CH / CL	Lower Chatham Strait	1,630	117.9	115.4-121.6
	CH / CL	Clarence Strait	754	138.5	130.0-143.0
Siddeek et al. (2022)	ln (CH/CL) / CL	WAG (1984/85)	508	108.8	103.8-126
	ln (CH/CL) / CL	EAG (1991/92)	3,247	104.1	84.5-111.8
	ln (CH/CL) / CL	AI	3,755	109.0	104.3-116.5
	CH / CL	WAG	5,361	120.8	112.6-126.1
	CH / CL	EAG	5,454	108.2	88.4-126.5
	CH / CL	AI	10,815	116.8	105.8-122.8
	CH / CL	AI (All Data)	14,570	122.9	120.4-125.1

$$CH = \beta_0 + \beta_1 CL + \beta_2 (x - \psi)^+ + \epsilon$$

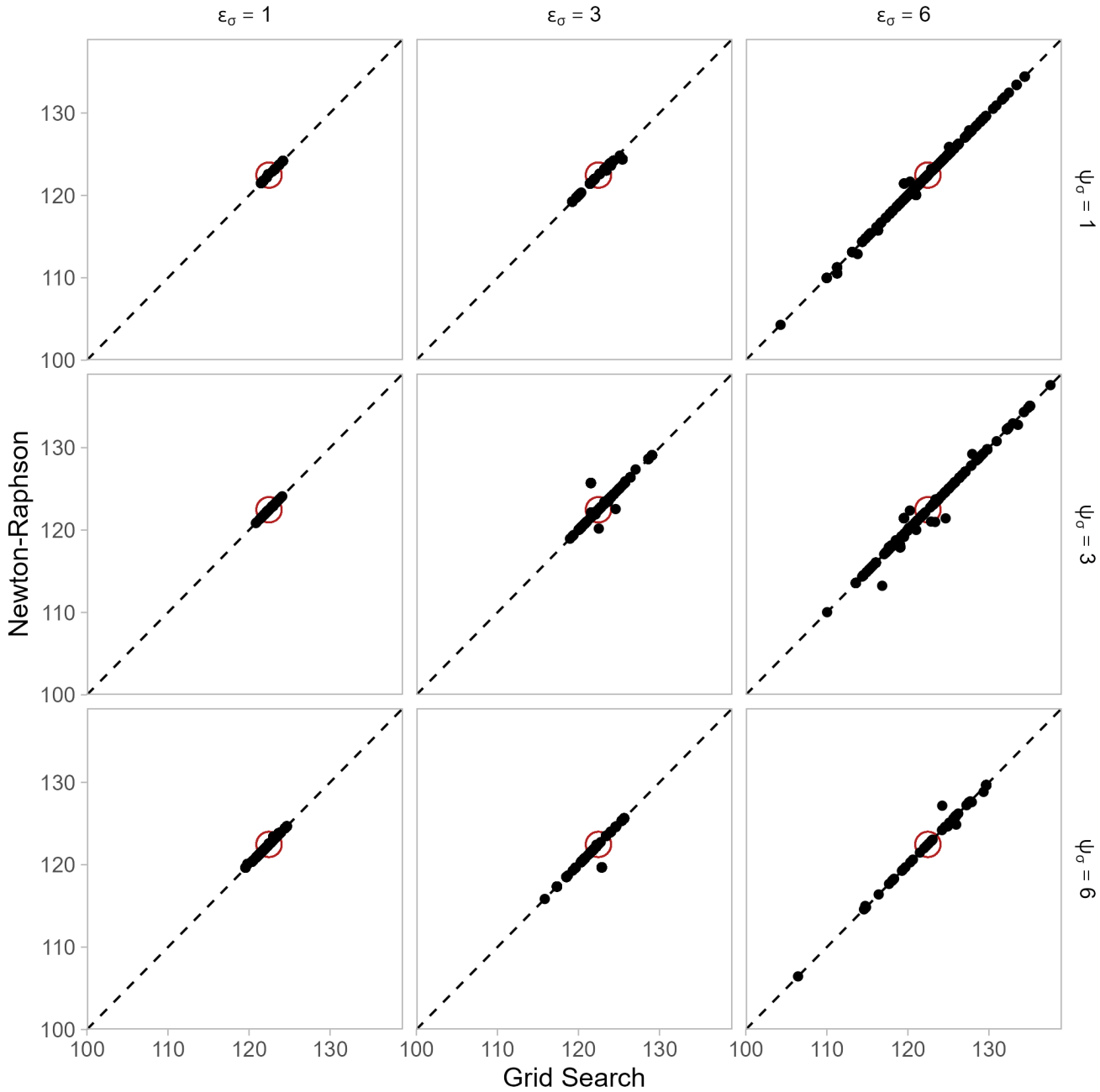


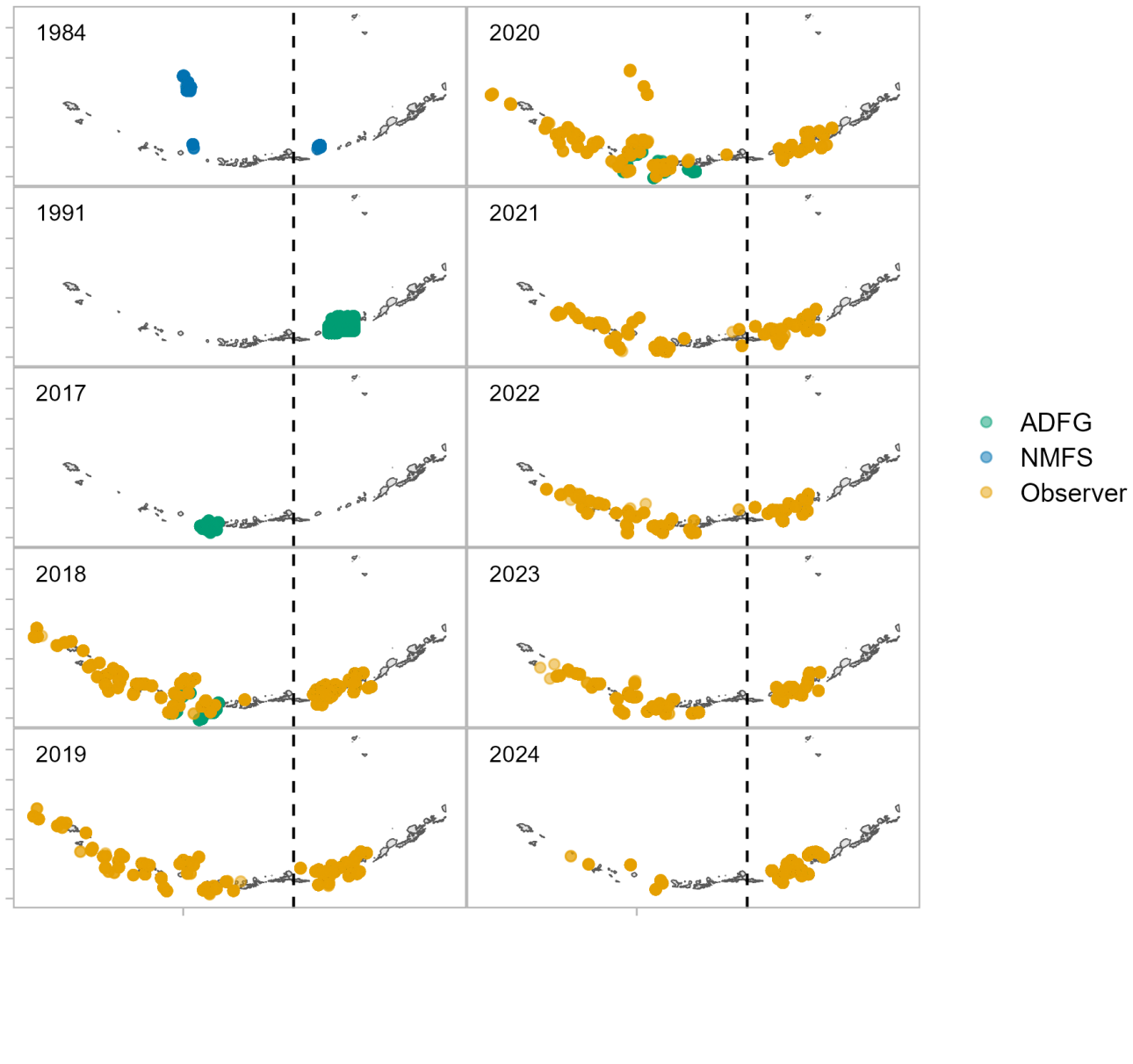
Breakpoint estimation methods

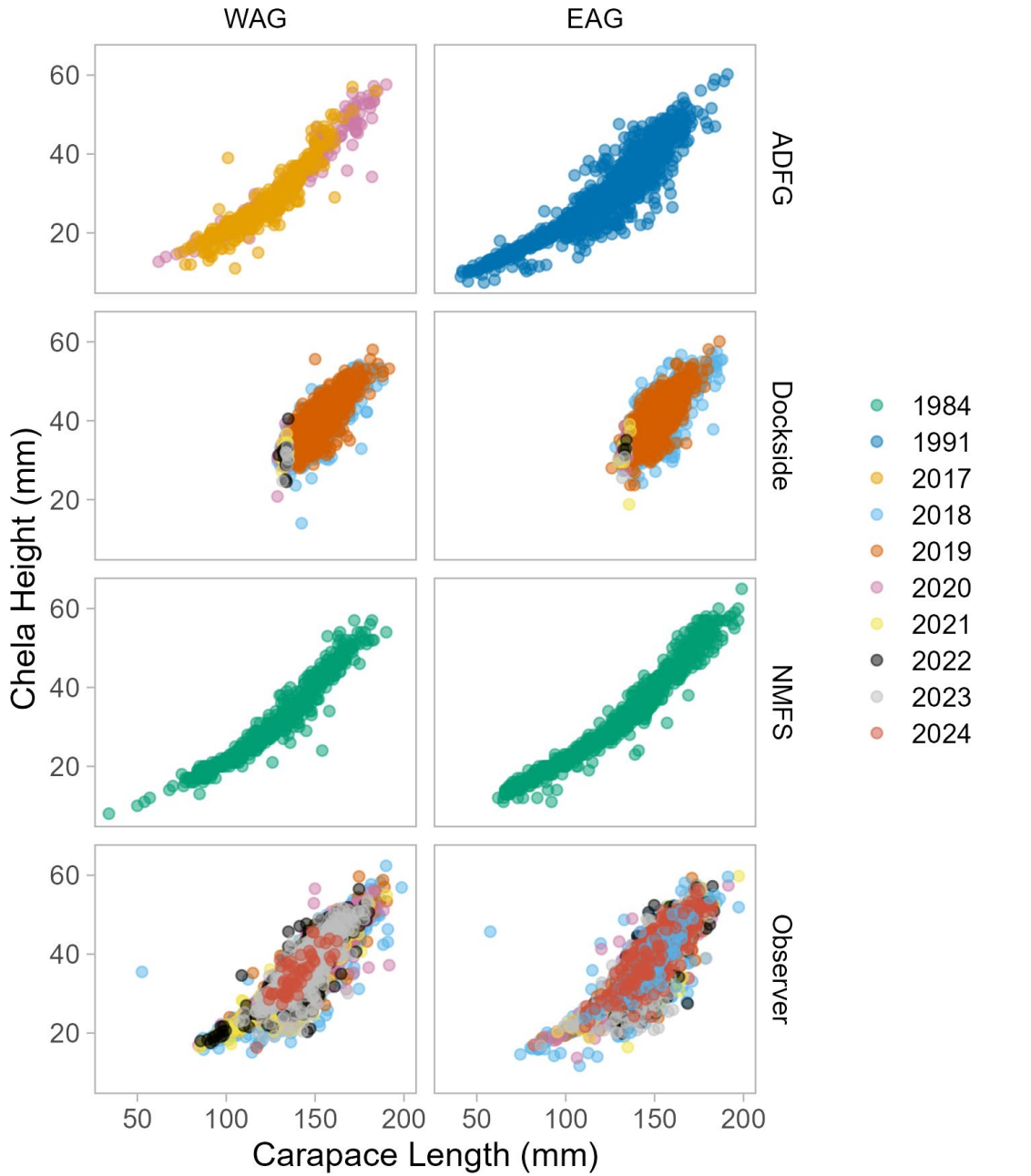
Olson et al. (2018) and Siddeek et al. (2022) used slightly different optimization methods

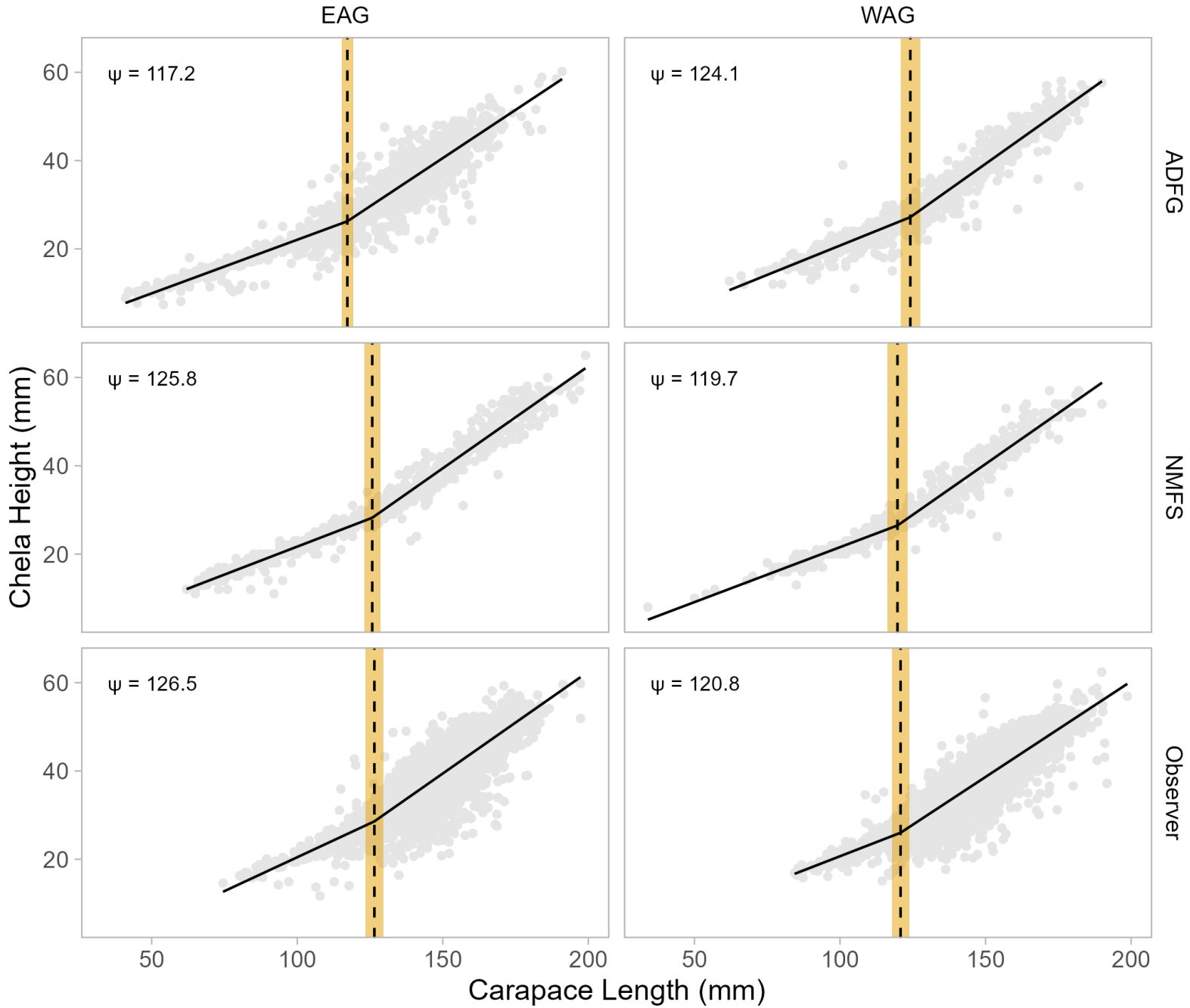
Olson et al. (2018) – *SiZer* – grid search

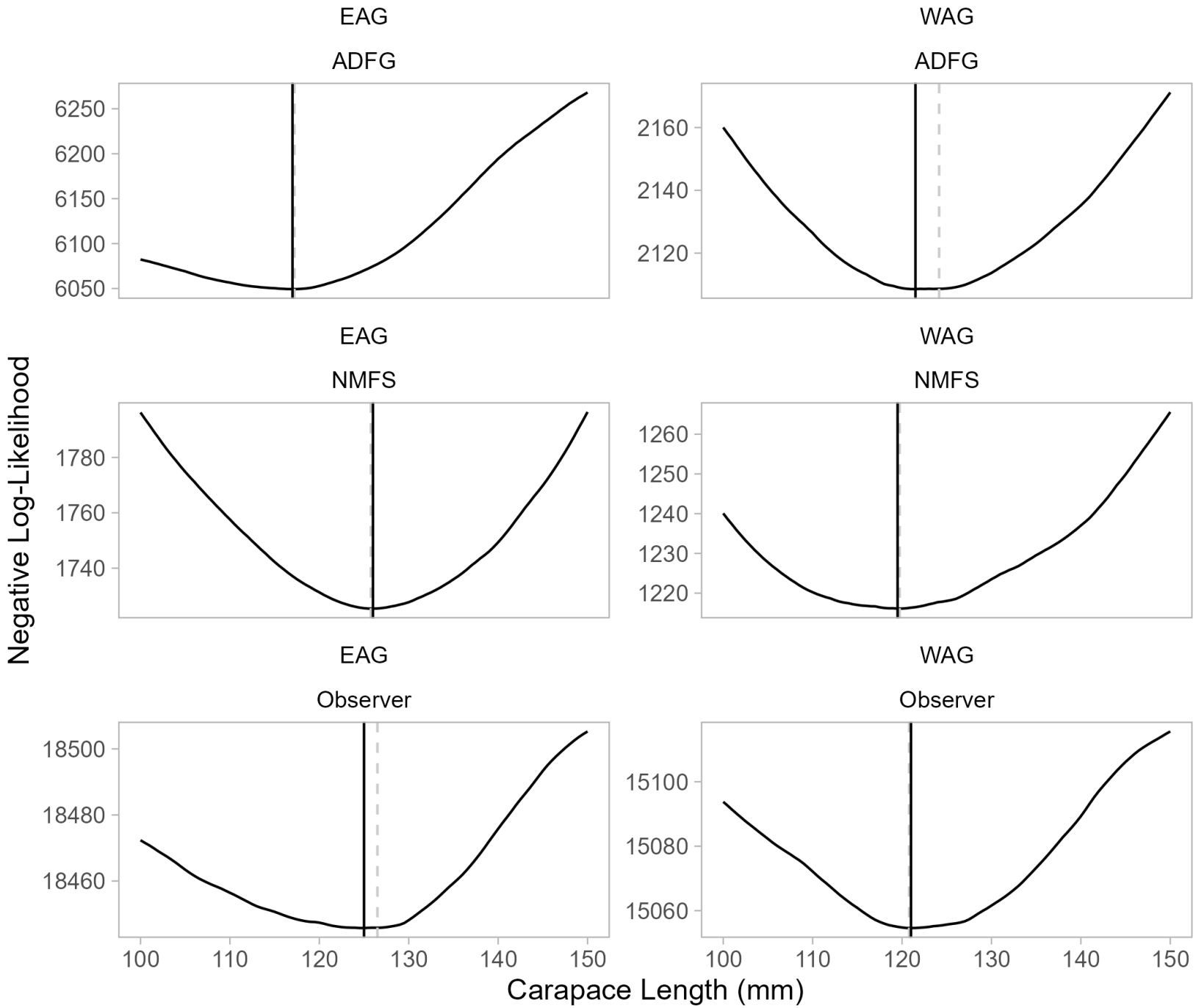
Siddeek et al. (2022) – *segmented* – Newton-Raphson optimization

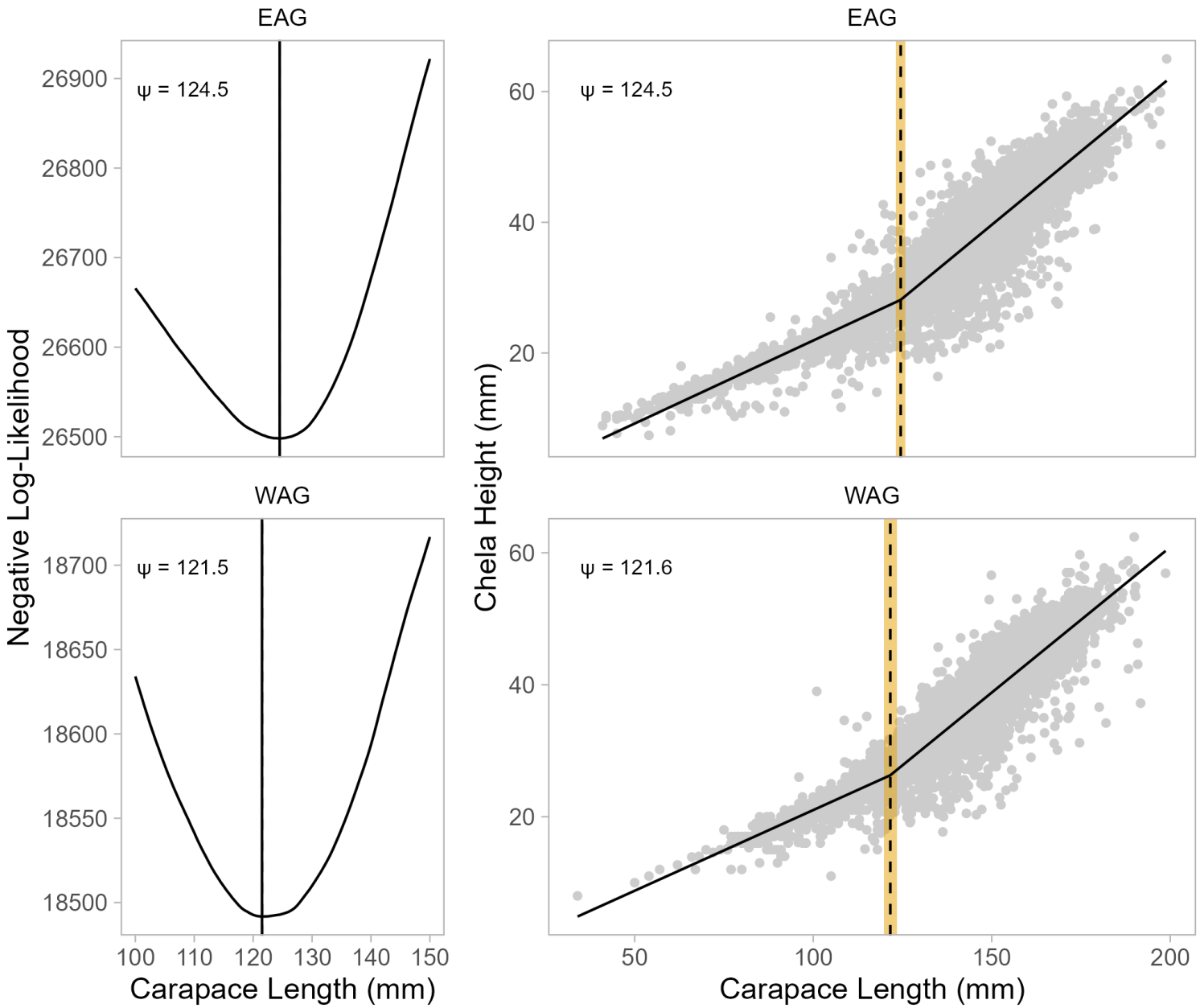

$\varepsilon_\sigma = 1$
$\varepsilon_\sigma = 3$
$\varepsilon_\sigma = 6$
$\psi_\sigma = 1$
$\psi_\sigma = 3$
$\psi_\sigma = 6$
Newton-Raphson
Grid Search
100
110
120
130

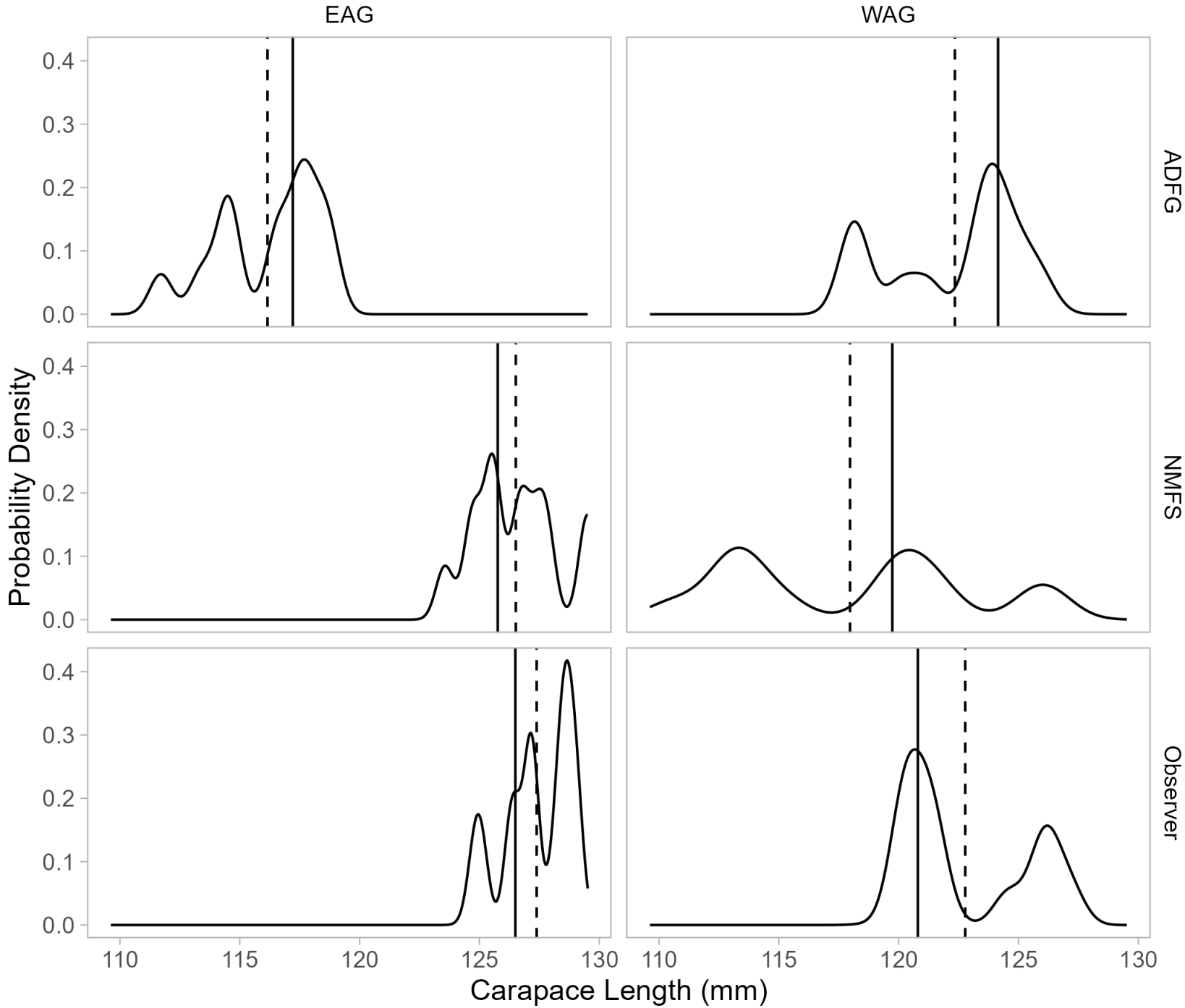

1984
2020
1991
2021
2017
2022
2018
2023
2019
2024
ADFG
NMFS
Observer

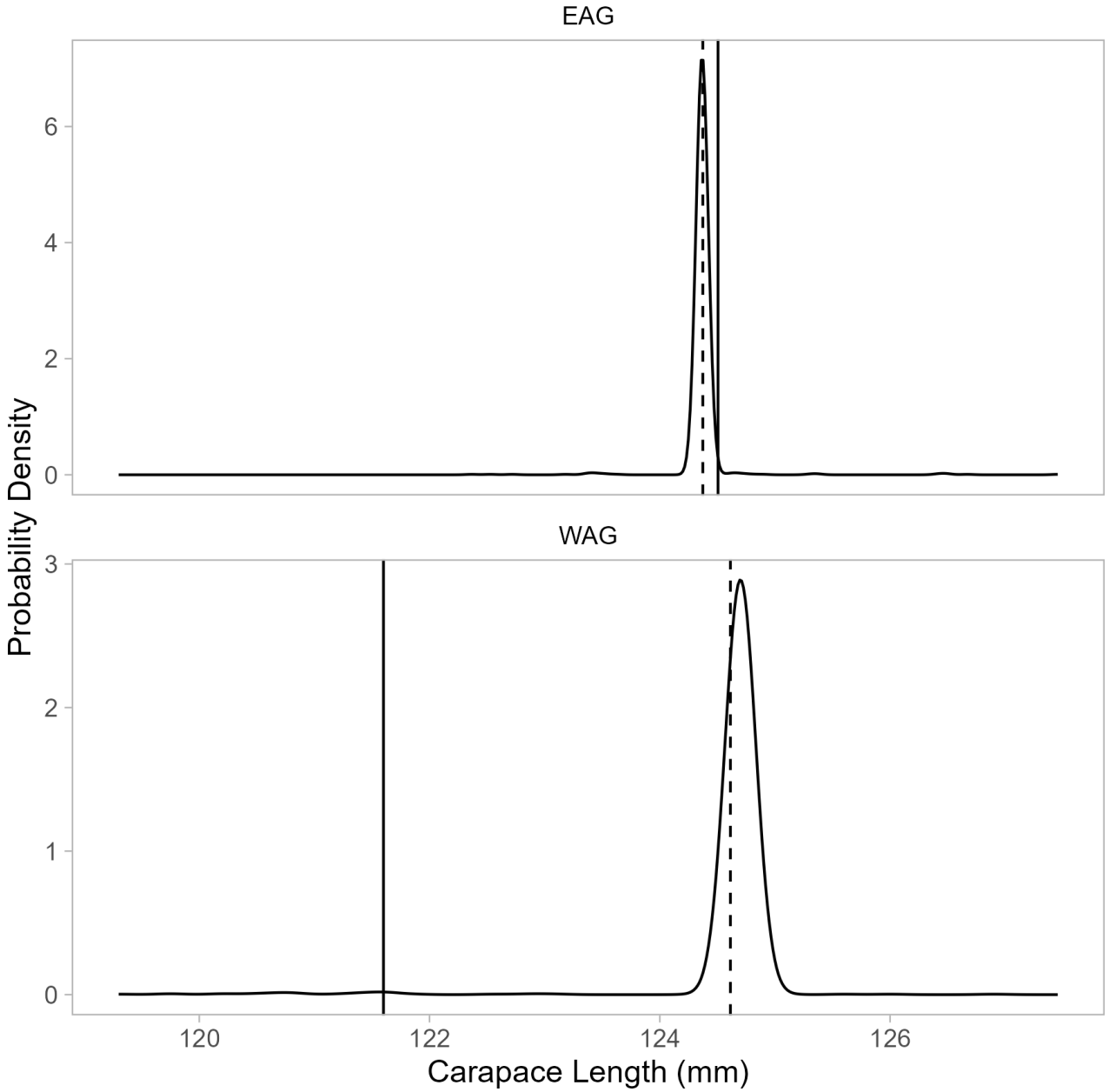

WAG
EAG
ADFG
Dockside
NMFS
Observer
Chela Height (mm)
Carapace Length (mm)
60
40
20
50
100
150
200
1984
1991
2017
2018
2019
2020
2021
2022
2023
2024


EAG
WAG
ADFG
NMFS
Observer
ψ = 117.2
ψ = 124.1
ψ = 125.8
ψ = 119.7
ψ = 126.5
ψ = 120.8
Chela Height (mm)
Carapace Length (mm)
20
40
60
50
100
150
200


EAG
ADFG
WAG
ADFG
EAG
NMFS
WAG
NMFS
EAG
Observer
WAG
Observer
Negative Log-Likelihood
Carapace Length (mm)
6250
6200
6150
6100
6050
2160
2140
2120
1780
1760
1740
1260
1250
1240
1230
1220
18500
18480
18460
15100
15080
15060
100
110
120
130
140
150


EAG
ψ = 124.5
26900
26800
26700
26600
26500
WAG
ψ = 121.5
18700
18650
18600
18550
18500
Negative Log-Likelihood
100
110
120
130
140
150
Carapace Length (mm)
EAG
ψ = 124.5
60
40
20
WAG
ψ = 121.6
60
40
20
Chela Height (mm)
50
100
150
200
Carapace Length (mm)


EAG
WAG
ADFG
NMFS
Observer
Probability Density
0.0
0.1
0.2
0.3
0.4
110
115
120
125
130
Carapace Length (mm)


EAG
WAG
Probability Density
0
2
4
6
0
1
2
3
120
122
124
126
Carapace Length (mm)

Conclusions

Don’t see an express need to do the bootstrapping…

Models seem to perform a bit better on the data in aggregate

Size at maturity probably between 110 – 130 mm

Lithodes link between physiological and functional maturity is poorly understood

Analysis should be refined a bit more (hopefully with feedback from CPT) before setting reference points with alternative MMB